Electronic Services - Hayward, Ca
M17280X

OPERATING HANDBOOK

SAM SERIES

SIGNAL ANALYSIS METER

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INTRODUCTION

The Wavetek SAM Series is a family of Signal Analysis Meters designed for the testing and maintenance of CATV systems. These meters cover portions or all of the CATV operating frequency range, and feature excellent accuracy specifications.

The SAM Series consists of Models SAM JR, SAM I, SAM III, SAM IIID, and SAM IV. The differences between the instruments are in the types of measurement possible with each instrument. Model SAM JR is a high-quality basic signal level meter. Model SAM I adds an internal calibrator and hum modulation, signal-to-noise, percent modulation, and voltage measurement capability. A spectrum analyzer is also available as an optional feature. Model SAM III includes the spectrum analyzer as a standard feature, and features microprocessor-controlled keyboard selection of channels and frequencies. Model SAM IIID adds an RS-232 interface, producing a computer-controlled version of Model SAM III. Model SAM IV adds a 7 inch CRT display, and is designed as a complete computer-controlled measurement system.

Models SAM IV, SAM IIID, and SAM III have a standard frequency range of 4 to 450 MHz. Model SAM I has a standard frequency range of 4 to 300 MHz, with a 4 to 450 MHz range optional. Model SAM JR has a 10 to 300 MHz standard frequency range, with a 50 to 450 MHz range optional. Each model is also available with a 470 to 890 MHz UHF band as an additional optional feature.

Models SAM IIID, SAM III, SAM I, and SAM JR are powered from internal rechargeable batteries, making them well-suited for either test bench or field use. Typical battery life is 4 hours of continuous operation for Models SAM IIID and SAM III, and 8 hours for Model SAM I and SAM JR. They may be recharged from either 110 or 220 VAC except for Model SAM JR, which can be recharged only from 110 VAC. Model SAM IV can be powered from either 110 or 220 VAC, and is designed principally for benchtop or rack-mounted installation.

SPECIFICATIONS FOR MODELS SAM IV, IIID, III

MEASUREMENT RANGES

FREQUENCY	4 to 450 MHz (470 to 890 MHz optional)
AMPLITUDE	-40 to +60 dBmV
HUM MODULATION	0.5 to 5%
VOLTAGE	5 to 100 VAC/VDC

MEASUREMENT ACCURACY

FREQUENCY	±0.1 MHz
AMPLITUDE	±0.5 dB at 70° F 10-400 MHz ±0.75 dB 400-450 MHz ±1.5 dB UHF
(SAM IV DX only)	±1 dB -40 to -30 dBmV
HUM MODULATION	±0.3%
VOLTAGE	±10%

CALIBRATOR

FREQUENCY	150 ±2 MHz
AMPLITUDE	+20 dBmV ±0.25 dB

SPECTRUM ANALYZER

FREQUENCY RANGE	Same as frequency measurement range.
AMPLITUDE RANGE	-40 to +60 dBmV ($\geqslant$ 40 dB displayed)
RATE	2 to 40 Hz continuously variable plus manual

DISPERSION	0.15 to 450 MHz continuously variable
HORIZONTAL OUTPUT (SAM IIID, III)	Approximately 0 to 9 V
VERTICAL OUTPUT (SAM IIID, III)	Approximately 0 to 2 V
SELECTIVITY	Sufficient to distinguish between two FM signals of equal amplitude 400 kHz apart. Sufficient to measure an audio carrier in the presence of an upper-channel video carrier 40 dB greater in amplitude.
IF BANDWIDTH	280 kHz at 3 dB point. 600 kHz at 40 dB point.
VIDEO OUTPUT	1 V output for full-scale meter reading.
DISPLAY (SAM IV ONLY)	
CRT	7 inch diagonal; P-1 phosphor
DEFLECTION	Magnetic
ACCELLERATION VOLTAGE	8 kV nominal
GRATICULE	9/16 in/division; 6 divisions vertical x 8 division horizontal
GENERAL (SAM IV)	
OPERATING TEMPERATURE RANGE	0 to 120° F
AC POWER REQUIREMENTS	110/220 VAC ±10%; 50 to 60 Hz; 100 W
DIMENSIONS	7 in high x 19 in wide x 12 in deep (designed to mount in standard 19 inch instrument rack)
WEIGHT	20 lbs.

GENERAL (SAM IIID, III)

OPERATING TEMPERATURE RANGE	0 to 120° F
AC POWER REQUIREMENTS (CHARGING ONLY)	110 VAC ±10% (220 VAC ±10% optional); 50 to 60 Hz; 30 W
INTERNAL BATTERY	12 V nominal; rechargeable; battery life typically 4 hours continuous operation.
DIMENSIONS	7 in high x 11 in wide x 10 in deep
WEIGHT	11 lbs.

SPECIFICATIONS FOR MODEL SAM I

MEASUREMENT RANGES

FREQUENCY	4 to 300 MHz (4 to 450 MHz optional) (470 to 890 MHz optional)
AMPLITUDE	-40 to +60 dBmV
HUM MODULATION	0.5 to 5%
VOLTAGE	5 to 100 VAC/VDC

MEASUREMENT ACCURACY

FREQUENCY	±2 MHz ±6 MHz UHF
AMPLITUDE	±0.5 dB at 70° F 10-400 MHz ±.75 dB 400-450 MHz ±1.5 dB UHF
HUM MODULATION	±0.3%
VOLTAGE	±10%

CALIBRATOR

FREQUENCY	150 ±2 MHz
AMPLITUDE	+20 dBmV ±0.25 dB

SPECTRUM ANALYZER (OPTIONAL)

FREQUENCY RANGE	Same as frequency measurement range.
AMPLITUDE RANGE	-40 to +60 dBmV (⩾ 40 dB displayed)
RATE	2 to 40 Hz continuously variable plus manual

DISPERSION	0.15 to 450 MHz continuously variable
HORIZONTAL OUTPUT	Approximately 0 to 9 V
VERTICAL OUTPUT	Approximately 0 to 2 V
SELECTIVITY	Sufficient to distinguish between two FM signals of equal amplitude 400 kHz apart. Sufficient to measure an audio carrier in the presence of an upper-channel video carrier 40 dB greater in amplitude.
IF BANDWIDTH	280 kHz at 3 dB point. 600 kHz at 40 dB point.
VIDEO OUTPUT	1 V output for full-scale meter reading.
GENERAL	
OPERATING TEMPERATURE RANGE	0 to 120° F
AC POWER REQUIREMENTS (CHARGING ONLY)	110 VAC ±10% (220 VAC ±10% optional); 50 to 60 Hz; 20 W
INTERNAL BATTERY	12 V nominal; rechargeable; battery life typically 8 hours continuous operation.
DIMENSIONS	7 in high x 11 in wide x 10 in deep
WEIGHT	11 lbs.

SPECIFICATIONS FOR MODEL SAM JR

MEASUREMENT RANGES

FREQUENCY	10 to 300 MHz (50 to 450 MHz optional) (470 to 890 MHz optional)
AMPLITUDE	-35 to +60 dBmV

MEASUREMENT ACCURACY

FREQUENCY	±2 MHz ±6 MHz UHF
AMPLITUDE	±0.75 dB (±2 dB over operating temperature range when calibrated at operating temperature)
SELECTIVITY	Sufficient to distinguish between two FM signals of equal amplitude 600 kHz apart. Sufficient to measure an audio carrier in the presence of an upper-channel video carrier 40 dB greater in amplitude.
IF BANDWIDTH	600 kHz at 3 dB point. 1.3 MHz at 40 dB point.

GENERAL

OPERATING TEMPERATURE RANGE	0 to 120° F
AC POWER REQUIREMENTS (CHARGING ONLY)	110 VAC ±10%; 50 to 60 Hz; 15 W
INTERNAL BATTERY	12 V rechargeable; battery life typically 8 hours continuous operation.
DIMENSIONS	6½ in high x 8¾ in wide x 6½ deep
WEIGHT	5.8 lbs.

ACCESSORIES FOR SAM SERIES INSTRUMENTS

FURNISHED WITH INSTRUMENT

Operating handbook
Voltmeter test leads (SAM IV, IIID, III, I only)
AC line cord (SAM IV, IIID, III, I only)
AC charger (SAM JR only)
Neck strap (SAM IIID, III, I, JR only)

AVAILABLE AT EXTRA COST

Protective nylon cover (SAM BAG; SAM IIID, III, I, JR only)
Test bench cabinet/stand (SAM IV only)
Strand hook (SKY-1; SAM IIID, III, I, JR only)
Return loss bridge, 75Ω, FB40-75
Adapter, F male to BNC female, AD903
Adapter, BNC female to BNC female, AD902
Terminator, 75Ω F male, T901
Matching pad, 50Ω to 75Ω BNC, M157
Matching pad, 75Ω to 50Ω BNC, M175
RF detector, 75Ω BNC, 0 to 1000 MHz, D171

OPERATOR CONTROLS FOR MODEL SAM IV

Refer to Figures 1a and 1b.

(1) ATTENUATOR control selects the RF input level range and METER scale to be read.

(2) SPEAKER gives audio output of demodulated signal.

(3) U/V switch selects UHF or VHF frequency range when UHF option is installed.

(4) METER indicates value of function being measured.

(5) TUNING control manually selects the frequency to be measured when the PGM/MAN switch is set to MAN.

(6) KEYBOARD selects the frequency or channel to be measured when the PGM/MAN switch is set to PGM.

(7) FREQUENCY DISPLAY (4 digits) indicates the frequency selected via the KEYBOARD or TUNING control.

(8) S/N switch enables internal compensation for 4 MHz bandwidth noise measurements.

(9) PGM/MAN switch enables either the KEYBOARD or TUNING control.

(10) AFC switch enables the internal AFC circuit.

(11) PIX/SND switch selects the video or audio carrier for measurement when a channel is programmed via the KEYBOARD.

(12) LIGHT switch provides backlighting for the METER.

(13) REMOTE lamp indicates the instrument is being programmed via the REMOTE connector.

(14) ON lamp indicates operation of the instrument.

(15) STANDBY lamp indicates the instrument is in "standby" mode.

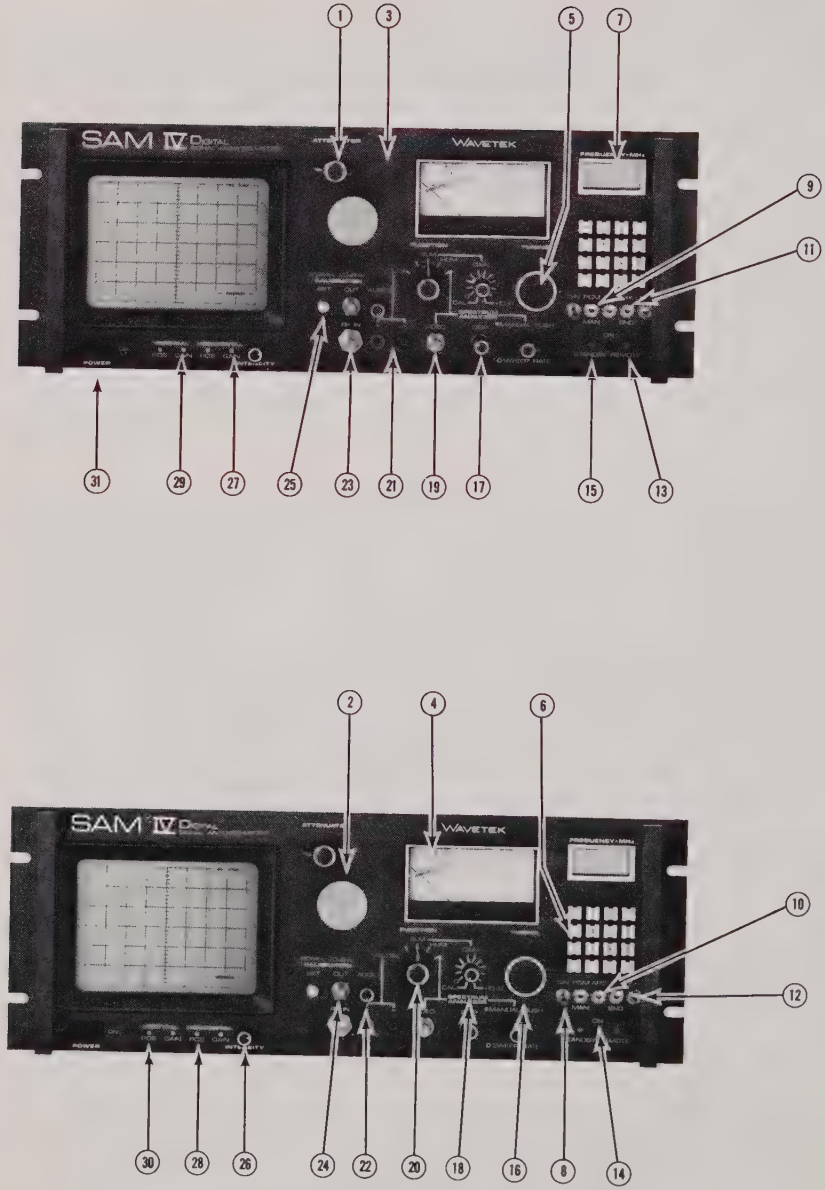


Figure 1a. Front Panel, Model SAM IV

(16) SWEEP RATE/MANUAL control selects between sweep (normal) and manual (momentarily pushed in) modes of the spectrum analyzer, and selects the analyzer sweep or manual rate.

(17) DISP control selects the spectrum analyzer dispersion.

(18) GAIN control provides 0 to 10 dB of level adjustment when the FUNCTION switch is set to SLM (signal level meter mode).

(19) VIDEO connector provides connection for the video output signal and the analyzer vertical output to an external oscilloscope.

(20) FUNCTION switch selects the function to be measured.

(21) +/– connectors accept test leads for voltage measurements when the FUNCTION switch is set to VOLTS.

(22) AUDIO control enables the internal audio circuit and adjusts the volume of the SPEAKER output.

(23) RF IN connector provides input for the signal to be measured.

(24) CALIBRATION OUT connector provides output from the internal calibrator to calibrate the METER for amplitude measurements.

(25) CALIBRATION SET control calibrates the METER for amplitude measurements.

(26) INTENSITY control adjusts the intensity of the CRT display.

(27) HORIZONTAL GAIN control calibrates the CRT display horizontal axis.

(28) HORIZONTAL POS control adjusts the horizontal positioning of the display trace.

(29) VERTICAL GAIN control calibrates the CRT display vertical axis.

(30) VERTICAL POS control adjusts the vertical positioning of the display trace.

(31) POWER switch applies DC power to the instrument.

(32) REMOTE connector (25 pin D-type) provides RS-232 interface connection for remote selection of frequency or channel.

(33) AC line cord connector/fuseholder provides connection to AC mains via 3-conductor line cord, and contains the AC line fuse and voltage selector card.

(34) Voltage selector card selects operating AC line voltage. Voltage selected should be visible when card is in place. (See Figure 1c.)

(35) AC line fuse is 1 A for 110 VAC; 1/2 A for 220 VAC.

(36) RF IN connector (same function as (23)).

(37) CALIBRATION OUT connector (same function as (24)).

NOTE

The RF IN (23,36) and CALIBRATION OUT (24,37) connectors are not totally independent. If the front-panel connectors are to be used, the rear-panel connectors must be connected together (a jumper cable is included with the instrument). If the rear-panel connectors are to be used, the front-panel connectors must be connected together.

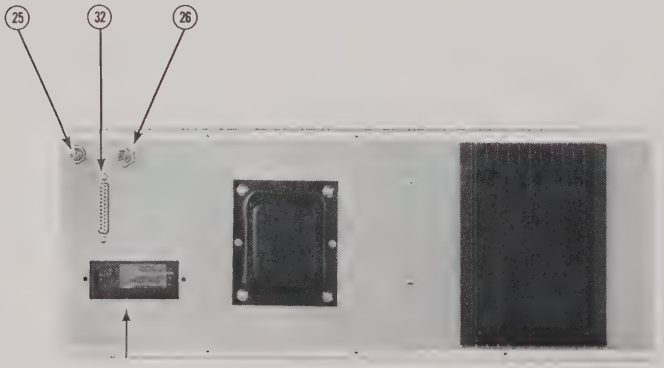


Figure 1b. Rear Panel, Model SAM IV

Remove the line cord and slide the window all the way to the left. Remove the fuse by pulling the lever. Remove the voltage-selector card. Orient the voltage-selector card so that the desired voltage is in the upper left and push the card firmly into the slot. Swing the lever to the right and check that the selected voltage is visible. Check that the fuse is the proper value for the selected voltage, replace the fuse, slide the window to the right, and replace the line cord.

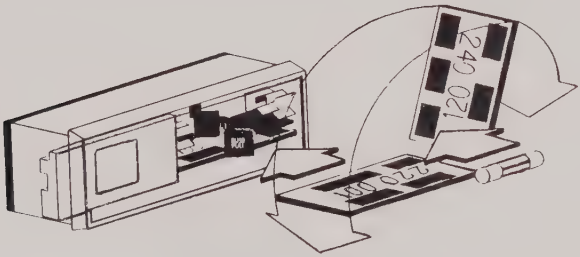


Figure 1c. Voltage Selection, Model SAM IV

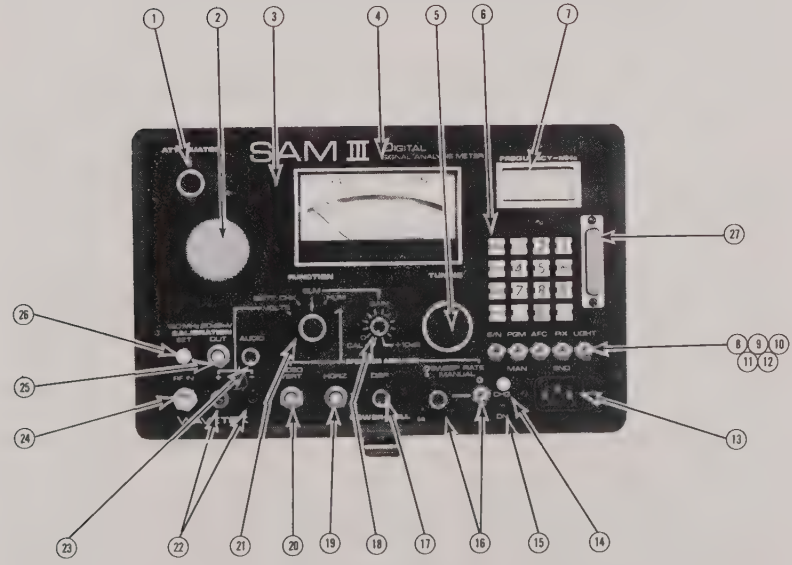


Figure 1d. Front Panel, Models SAM IIID, SAM III

OPERATOR CONTROLS FOR MODELS SAM IIID, III

Refer to Figure 1d.

(1) ATTENUATOR control selects the RF input level range and METER scale to be read.

(2) SPEAKER gives audio output of demodulated signal.

(3) U/V switch selects UHF or VHF frequency range when UHF option is installed.

(4) METER indicates value of function being measured.

(5) TUNING control manually selects the frequency to be measured when the PGM/MAN switch is set to MAN.

(6) KEYBOARD selects the frequency or channel to be measured when the PGM/MAN switch is set to PGM.

(7) FREQUENCY DISPLAY (4 digits) indicates the frequency selected via the KEYBOARD or TUNING control.

(8) S/N switch enables internal compensation for 4 MHz bandwidth noise measurements.

(9) PGM/MAN switch enables either the KEYBOARD or TUNING control.

(10) AFC switch enables the internal AFC circuit.

(11) PIX/SND switch selects the video or audio carrier for measurement when a channel is programmed via the KEYBOARD.

(12) LIGHT switch provides backlighting for the METER.

(13) AC line connector provides connection to AC mains via three-conductor line cord.

(14) CHG lamp indicates the internal battery is being charged.

(15) ON lamp indicates operation of the instrument.

(16) SWEEP RATE/MANUAL switch selects between sweep and manual modes of the spectrum analyzer. The control selects the analyzer sweep or manual rate.

(17) DISP/POWER control applies DC power to the instrument when pulled out, and selects the spectrum analyzer dispersion.

(18) GAIN control provides 0 to 10 dB of level adjustment when the FUNCTION switch is set to SLM (signal level meter mode).

(19) HORIZ connector provides the analyzer horizontal output for an oscilloscope.

(20) VIDEO/VERT connector provides connection for the video output signal and the analyzer vertical output for an oscilloscope.

(21) FUNCTION switch selects the function to be measured.

(22) +/— connectors accept test leads for voltage measurements when the FUNCTION switch is set to VOLTS.

(23) AUDIO control enables the internal audio circuit and adjusts the volume of the SPEAKER output.

(24) RF IN connector provides input for the signal to be measured.

(25) CALIBRATION OUT connector provides output from the internal calibrator to calibrate the METER for amplitude measurements.

(26) CALIBRATION SET control calibrates the METER for amplitude measurements.

(27) REMOTE connector (25 pin D-type) provides RS-232 interface connection for remote selection of frequency or channel. (NOTE: This connector is not on Model SAM III.)

OPERATOR CONTROLS FOR MODEL SAM I

Refer to Figure 1e.

(1) ATTENUATOR control selects the RF input level range and METER scale to be read.

(2) SPEAKER gives audio output of demodulated signal.

(3) METER indicates value of function being measured.

(4) BAND switch selects TUNING control frequency range.

(5) TUNING control selects the frequency to be measured.

(6) FINE TUNE control provides fine adjustment for TUNING control setting.

(7) S/N switch enables internal compensation for 4 MHz bandwidth noise measurements.

(8) LIGHT switch provides backlighting for the METER.

(9) AFC switch enables the internal AFC circuit.

(10) U/V switch selects UHF or VHF frequency range when UHF option is installed.

(11) AC line connector provides connection to AC mains via three-conductor line cord.

(12) CHG lamp indicates the internal battery is being charged.

(13) ON lamp indicates operation of the instrument.

(14) SWEEP RATE/MANUAL switch selects between sweep and manual modes of the spectrum analyzer when the spectrum analyzer option is installed. The control selects the analyzer sweep or manual rate.

(15) DISP/POWER control applies DC power to the instrument when pulled out, and selects the spectrum analyzer dispersion when the spectrum analyzer option is installed.

(16) GAIN control provides 0 to 10 dB of level adjustment when the FUNCTION switch is set to SLM (signal level meter mode).

(17) HORIZ connector provides the analyzer horizontal output for an oscilloscope when the spectrum analyzer option is installed.

(18) VIDEO/VERT connector provides connection for the video output signal and the analyzer vertical output for an oscilloscope when the spectrum analyzer option is installed.

(19) FUNCTION switch selects the function to be measured.

(20) AUDIO control enables the internal audio circuit and adjusts the volume of the SPEAKER output.

(21) +/— connectors accept test leads for voltage measurements when the FUNCTION switch is set to VOLTS.

(22) RF IN connector provides input for the signal to be measured.

(23) CALIBRATION OUT connector provides output from the internal calibrator to calibrate the METER for amplitude measurements.

(24) CALIBRATION SET control calibrates the METER for amplitude measurements.

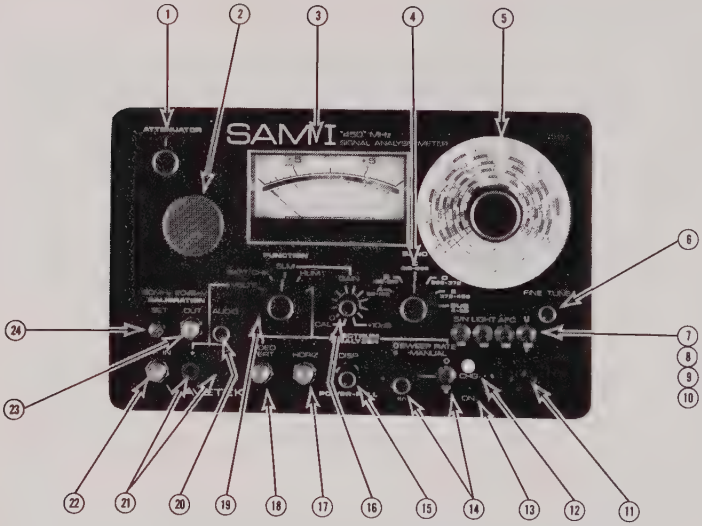


Figure 1e. Front Panel, Model SAM I

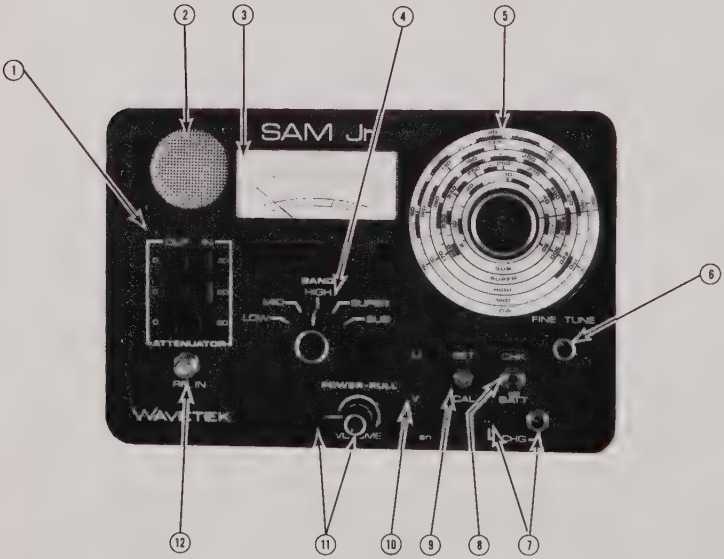


Figure 1f. Front Panel, Model SAM JR

OPERATOR CONTROLS FOR MODEL SAM JR

Refer to Figure 1f.

(1) ATTENUATOR switches decrease the RF input level in 20 dB steps to provide an on-scale METER reading.

(2) SPEAKER gives audio output of demodulated signal.

(3) METER indicates value of function being measured.

(4) BAND switch selects TUNING control frequency range.

(5) TUNING control selects the frequency to be measured.

(6) FINE TUNE control provides fine adjustment for TUNING control setting.

(7) CHG connector accepts AC input from battery charger. Lamp indicates the internal battery is being charged.

(8) CHK BATT switch gives battery charge indication on the METER.

(9) SET CAL control calibrates the METER for amplitude measurements.

(10) U/V switch selects UHF or VHF frequency range when UHF option is installed.

(11) POWER/VOLUME control applies DC power to the instrument when pulled out, and enables the internal audio circuit and adjusts the volume of the SPEAKER output.

(12) RF IN connector provides input for the signal to be measured.

OPERATING NOTES

INTRODUCTION

This section provides information for the basic set-up and operation of the SAM Series Signal Analysis Meters. Special features and applications will be covered in later sections.

FREQUENCY SELECTION (MODELS SAM I, JR)

Set the BAND switch for the desired frequency range on the TUNING control dial, then set the TUNING control for the desired frequency. Fine adjustment of the selected frequency may be made with the FINE TUNE control.

The red arcs on the TUNING control dial indicate standard channel frequencies. The left edge of the red arc represents the video carrier of the channel, while the right edge represents the audio carrier.

NOTE

On instruments with the optional 450 MHz range, only every other channel is indicated with a red arc.

FREQUENCY/CHANNEL SELECTION (MODELS SAM IV, IIID, III)

TUNING CONTROL (FREQUENCY)

Set the PGM/MAN switch to MAN and adjust the TUNING control until the FREQUENCY DISPLAY indicates the desired frequency. (The FREQUENCY display readout is in MHz with 0.1 MHz resolution.)

KEYBOARD (FREQUENCY)

Set the PGM/MAN switch to PGM. Enter the desired frequency (in MHz) via the KEYBOARD number keys and then depress the FRQ key. The FREQUENCY DISPLAY will indicate the selected frequency in MHz.

If an error in frequency selection is made, the CLR key resets the KEYBOARD for entry and clears the FREQUENCY DISPLAY.

If the NEXT key is depressed after a frequency has been entered, the KEYBOARD program will select standard channel 2 as its default status.

KEYBOARD (CHANNEL)

Set the PGM/MAN switch to PGM. Enter the channel number via the KEYBOARD number keys and then depress either the CHN or CHN (HRC) key, as desired.

NOTE

THE CHN key will select standard channel frequencies. The CHN (HRC) key will select harmonically related carrier (HRC) channel frequencies. All channels are programmed by standard converter numbers 2 through 60.

Set the PIX/SND switch as desired. The "PIX" position selects the video carrier. The "SND" position selects the audio carrier. The video and audio carrier frequencies for channels 2 through 60 have been stored internally in the instrument's memory. The FREQUENCY DISPLAY will show the frequency of the selected carrier in MHz.

In order to select the next-higher-frequency channel (in either standard or HRC format), depress the NEXT key.

If an error in channel selection is made, the CLR key resets the KEYBOARD for entry and clears the FREQUENCY DISPLAY.

REMOTE (MODELS SAM IV, IIID)

Remote frequency and channel selection is accomplished in the same manner as from the KEYBOARD, except that the programming device (remote keyboard, terminal, or computer) is connected to the instrument via the REMOTE connector. The instrument does not distinguish between entries from the KEYBOARD and entries via the REMOTE connector. It recognizes only the last entry received from either source.

Refer to the Programming section of this handbook for more complete information regarding remote operation.

AFC (MODELS SAM IV, IIID, III)

The automatic frequency control (AFC) circuit serves to capture or hold the tuning to the highest-level signal within its tuned bandwidth. For most applications, the AFC switch should be on ("up" position).

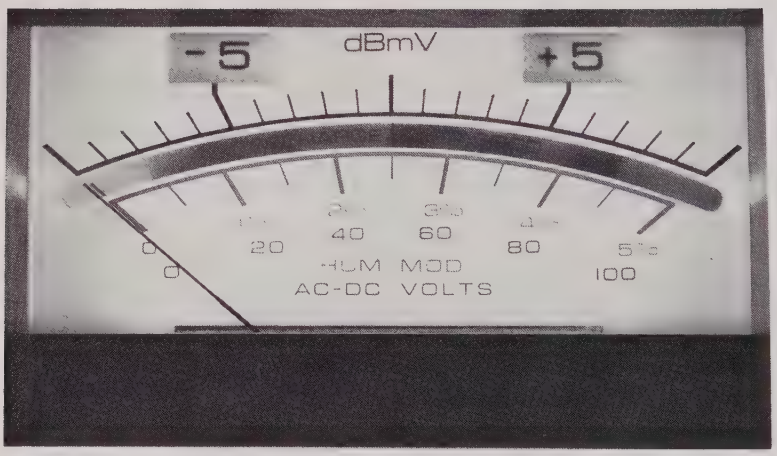


Figure 2a. METER, Models SAM IV, SAM IIID, SAM III, SAM I

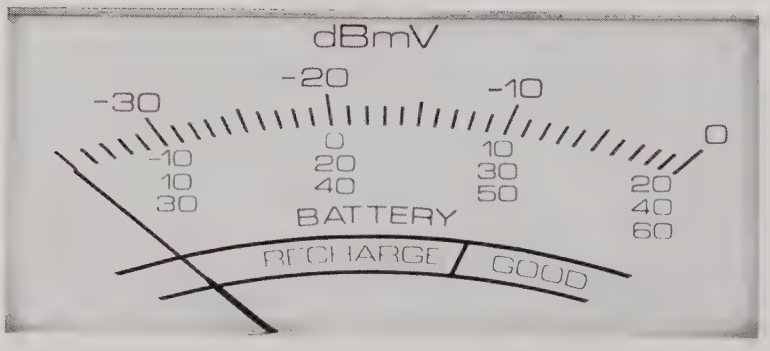


Figure 2b. METER, Model SAM JR

Setting the switch to its "down" position disables the AFC circuit. This would be desireable in a case where two signals (e.g. a carrier and low-level beat) are extremely close together in frequency and the lower-level signal is the signal of interest. The AFC can be disabled and the TUNING or FINE TUNE control adjusted slightly to tune to the lower-level signal frequency.

METER (MODELS SAM IV, IIID, III, I)

There are four scales on the METER face (see Figure 2a). The top scale is for signal level measurements in dBmV. The second scale is for checking the battery charge level, and is divided into RECHARGE and BATT GOOD regions. The third scale is for hum modulation measurements in peak-to-peak %. The fourth scale is for AC/DC voltage measurements in volts.

The second, third, and fourth scales are very straightforward, and require no explanation. The top scale, however, changes with the ATTENUATOR control setting. The top scale has a range of 20 dB, and is graduated in 1 dB and 5 dB increments. The numbers in the windows of the METER face indicate the levels 5 dB below and 5 dB above the mid-scale level in dBmV (provided the GAIN control is set to CAL). The maximum METER scale reading is therefore 5 dB above the right window value and the minimum METER scale reading is 5 dB below the left window value. The values in the windows change as the ATTENUATOR control is adjusted, therefore the METER scale always shows the correct range for the ATTENUATOR control setting.

NOTE

If the GAIN control is not set to CAL, the METER scale is negatively offset by the GAIN control setting (0 to 10 dB).

METER (MODEL SAM JR)

There are five scales on the METER face (see Figure 2b). The bottom scale is for checking the battery charge level. This scale is very straightfoward and requires no explanation. The top four scales are for signal level measurements in dBmV. Each scale has a 35 dB range. Which scale is to be read is determined by how many of the 20 dB ATTENUATOR switches are set to IN. With all ATTENUATOR switches set to OUT, the top (-35 to 0 dBmV) range is read. With one ATTENUATOR switch set to IN, the second (-15 to +20 dBmV) scale is read. With two ATTENUATOR switches set to IN, the third (+5 to +40 dBmV) scale is read. With all ATTENUATOR switches set to IN, the bottom (+25 to +60 dBmV) scale is read.

GAIN CONTROL (MODELS SAM IV, IIID, III, I)

The GAIN control acts to negatively offset the indicated METER range by up to 10 dB when the FUNCTION switch is set to SLM. The major use of this control is to extend the METER range when measuring very-low-level ($\leqslant$ -30 dBmV) signals. This effectively changes the lowest METER range from [-30 to -10 dBmV] to [-40 to -20 dBmV].

Another use of the GAIN control is in making a comparison of two or more signals. A reference METER reading can be set by adjusting the GAIN control, and the other signals read as dB referenced to the first signal. This technique can be useful in reading all signals of interest on the same METER scale without changing the ATTENUATOR control setting.

CALIBRATION SETTING (MODELS SAM IV, IIID, III, I)

The instrument contains an internal calibration source which provides a high-accuracy +20 dBmV at 150 MHz signal at the CALIBRATION OUT connector.

Set the FUNCTION switch to SLM. Using the cable which will be used to make signal level measurements, connect the CALIBRATION OUT connector to the RF IN connector. Set the ATTENUATOR control such that +15 and +25 appear in the METER windows and set the GAIN control to CAL. Select 150 MHz tuning frequency and adjust the CALIBRATION SET control such that the METER reads exactly +20 dBmV. The instrument signal level measurement system is now calibrated to an accuracy of ±.25 dB at the actual operating temperature.

CALIBRATION SETTING (MODEL SAM JR)

Using the cable which will be used to make signal level measurements, connect a meter calibrator (Wavetek Model MC-50 or equivalent) to the RF IN connector. Set the meter calibrator for +50 dBmV at 150 MHz. Select 150 MHz tuning frequency and adjust the CAL SET control such that the METER reads exactly +50 dBmV. The instrument signal level measurement system is now calibrated to the accuracy of the meter calibrator at the actual operating temperature.

NOTE

Frequencies and levels other than 150 MHz and +50 dBmV may be used, if desired.

BATTERY CHECK (SAM IIID, III, I, JR)

On Models SAM IIID, III, I, set the FUNCTION switch to BATT CHK. On Model SAM JR, set the BATT CHK switch to its "up" position. The METER will indicate the charge level. If the METER reading is within the BATT GOOD arc, the battery charge level is sufficient to assure proper operation of the instrument. If the METER reading is within the RECHARGE arc, the battery should be recharged before further tests are performed.

UHF

Operation of instruments equipped with the UHF option is identical to that of instruments without the UHF option, with the exception that more frequencies are available for analysis.

On Models SAM IV, IIID, and III, the U/V switch is set to "U" and the desired frequency or channel is selected in the same manner as for the VHF frequencies.

On Models SAM I and JR, the U/V switch is set to "U", the desired band is selected via the BAND switch, and the TUNING control set to the desired frequency. The UHF bands and standard channels are indicated on the TUNING control dial, with the video carrier for each channel indicated by a red "■" on the perimeter of the dial.

SPECTRUM ANALYZER

The spectrum analyzer (standard on Models SAM IV, IIID, and III, optional on Model SAM I) provides a visual X-Y display of signal amplitude versus frequency. (Model SAM IV contains its own display; Models SAM IIID, III and I require an external display oscilloscope connected via the VIDEO/VERT and HORIZ connectors.)

The SAM spectrum analyzer has two main controls. The DISPERSION control selects the frequency range displayed on the analyzer X-axis (equivalent to sweep width in a sweep generator). The SWEEP RATE/MANUAL control either selects the repetition rate of the display, or permits the displayed frequency to be manually selected.

The center frequency on the analyzer display X-axis is the frequency selected via the TUNING control. The amplitude range displayed on the analyzer Y-axis is determined by the ATTENUATOR control setting.

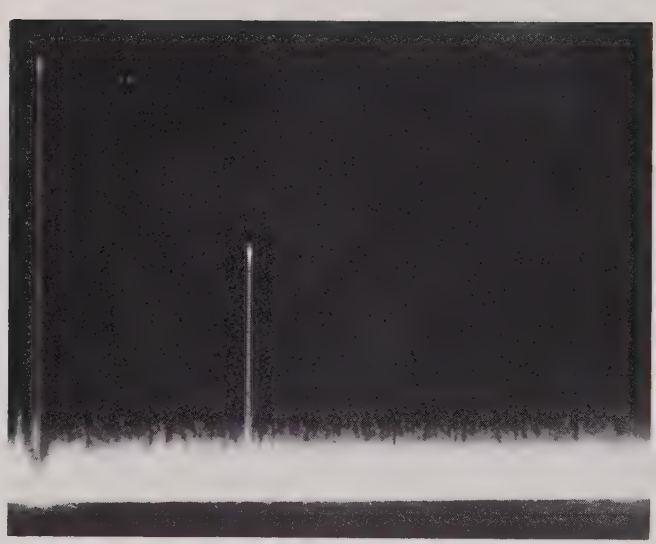


Figure 3. Calibrator Signal, Wide Dispersion

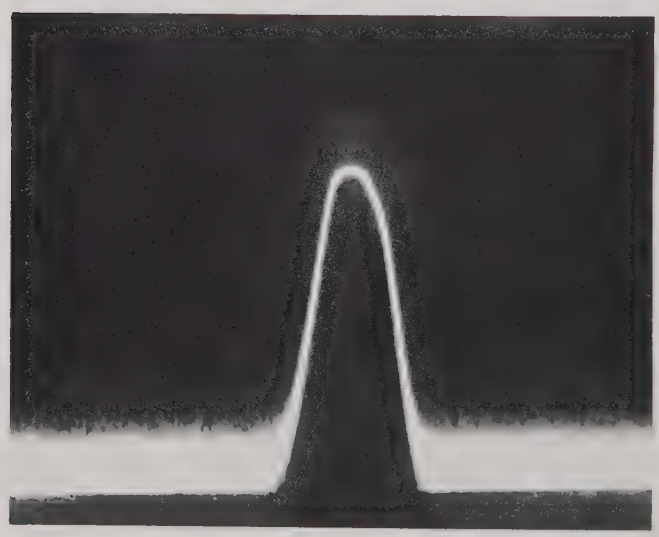


Figure 4. Calibrator Signal, Narrow Dispersion

SPECTRUM ANALYZER DISPLAY

Figure 3 shows a spectrum analyzer display of the internal calibrator signal (+20 dBm at 150 MHz). The DISP control is set for a 450 MHz frequency (X) axis display. The ATTENUATOR control is set such that +15 and +25 appear in the METER windows, producing the amplitude (Y) axis scale.

Figure 4 also shows the internal calibrator signal, but the DISP control has been set for a 5 MHz frequency axis display (since the frequency axis is linear, each division represents 500 kHz). The display can be thought of as a graph of a series of discrete level measurements plotted versus frequency. In this case, the measurements are made for an infinite number of frequency points which comprise the frequency range being displayed.

With multiple signals present, the exact shape of the display can be somewhat dependent on the resolution of the spectrum analyzer. This factor determines how close together in frequency two signals can be and still permit differentiation between them, and is, in turn, a function of the analyzer IF bandwidth. (In signal level meters, this factor is called selectivity.) The resolution of the SAM analyzer is sufficient for level setting, video-to-audio setting, harmonic/spurious signals checks, and system sweeping. It is not, however, sufficient for co-channel or cross-modulation testing.

AMPLITUDE AXIS

The amplitude (Y) axis of the display is logarithmic in dB, meaning that a signal level change of N dB will produce the same display variation whether it occurs at the top or bottom of the display screen. This is preferable to a linear display, since most signal levels and changes are expressed in dB (a logarithmic function), and the analyzer's dynamic range is greater with a logarithmic display. The $\geqslant$ 40 dB dynamic range means that signal level variations of 40 dB or more can be observed on the display.

SPECTRUM ANALYZER SETUP

Set the FUNCTION switch to SPECTRUM ANALYZER, the DISP control fully cw, the SWEEP RATE as desired (but not in manual mode), the ATTENUATOR control such that +25 and +35 appear in the METER windows, and the AFC switch down. If using a SAM IV, IIID, or III, set the PGM/MAN switch to MAN. Insert a CW signal of known frequency ($\leqslant$ 225 MHz) and amplitude (such as the +20 dBmV at 150 MHz internal calibrator signal from the CALIBRATION OUT connector) into the RF IN connector. Set the TUNING control

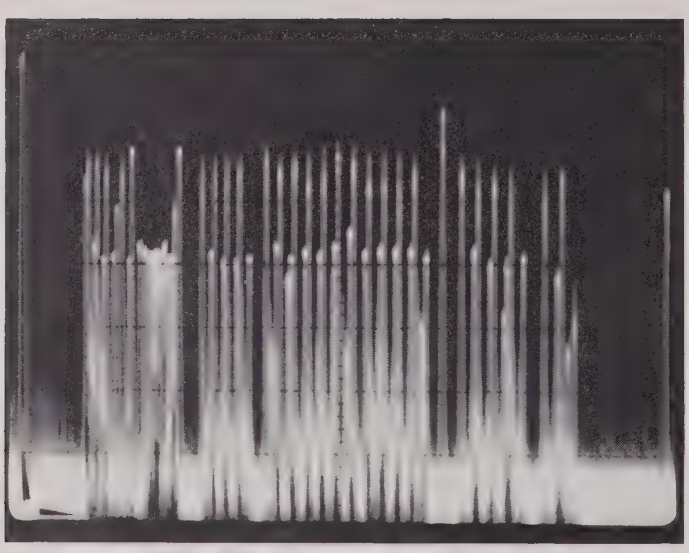


Figure 5. VHF Display, Wide Dispersion

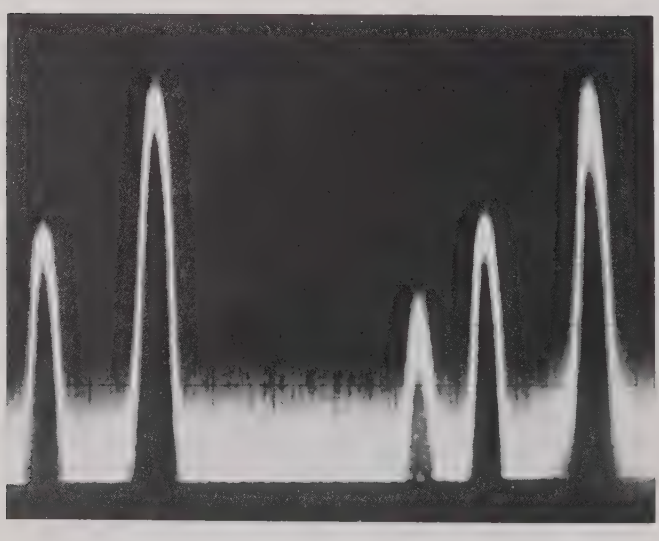


Figure 6. VHF Display, Narrow Dispersion

to match the known CW signal frequency and adjust the ATTENUATOR control such that the known CW signal amplitude is ~15 dB above the higher METER window value.

If using a SAM IIID, III, or I, connect the HORIZ and VIDEO/VERT connectors to the display oscilloscope horizontal and vertical inputs, respectively. Set the oscilloscope's vertical sensitivity to 0.5 V/division and the horizontal sensitivity to 1 V/division. Adjust the oscilloscope's horizontal controls to produce a trace exactly 8 divisions wide.

The analyzer zero frequency reference should appear on the far left vertical graticule line, and the known CW frequency should appear at the center vertical graticule line. The frequency axis is now calibrated from 0 to twice the known CW frequency, with each division representing the known CW frequency divided by 4 (twice the known CW frequency divided by 8 divisions).

NOTE

Other methods of calibrating the frequency axis are equally acceptable. Since the frequency axis is relatively linear, all that is really required are two known frequency points, one of which may be (but not need be) zero. The frequency axis scale may be determined from these two known frequency points.

Adjust the oscilloscope's vertical controls to produce a display trace height of the known CW signal of exactly 6 divisions above the base line, with the peak of the known CW trace touching the top horizontal graticule line. The top graticule line is thus calibrated at the known CW signal level, with each vertical division representing 10 dB.

Disconnect the known CW signal and connect the system signals to be measured. Set the ATTENUATOR control such that the peak of the greatest-amplitude signal does not go above the top horizontal graticule line. Signal levels may be read directly from the display (accuracy = ±2 dB).

Figure 5 shows a typical VHF display. To look at a single channel or a narrow range of frequencies, set the TUNING control for the desired center frequency and narrow the analyzer dispersion until just the desired range of frequencies is displayed (see Figure 6).

On Models SAM IV, IIID, and III, as the analyzer sweeps the frequency range of interest, the digital FREQUENCY DISPLAY will follow the tuning frequency as it is being swept. In most cases, however, the sweep rate will be too fast for a useful readout.

If the analyzer is placed in its manual mode, however (using the SWEEP RATE/MANUAL switch), the MANUAL control becomes a tuning control for the frequency range selected. The range may be slowly swept (the display will be a bright spot), and the FREQUENCY DISPLAY will indicate the exact frequency set via the MANUAL control. This feature is very useful in determining the exact (±200 kHz) frequency of a specific signal. (Narrowing the analyzer dispersion before switching to manual often results in easier "peaking" of the display on the signal of interest with the MANUAL control.)

NOTE

On Model SAM IV, the SWEEP RATE/MANUAL switch is momentary to prevent damage to the CRT display phosphor. The control must be held in to maintain the manual mode.

SAM IIIE

The Model SAM IIIE performs the same functions as the SAM III with the following exceptions:

The frequency range has been extended to 600 MHz for the SAM IIIE.

The SAM IIIE has a channel identification feature not found on the SAM III. During operation the tuned frequency is shown on the LCD (Liquid Crystal Display) of either unit. When the CHAN key is pressed on the SAM IIIE, the channel number to which the unit is tuned will be displayed momentarily. This feature may be used to "relocate" a forgotten channel number when using the NEXT key.

The SAM IIIE also has an "out of measurement range" indicator. For example, if a frequency request that is beyond the measurement range of the SAM IIIE is entered, the LCD will display bars to indicate an invalid request.

The front panel layout has been re-arranged slightly on the SAM IIIE.

Please note that all of the functions of the SAM III have been retained in the SAM IIIE.

SAM IV DX

The SAM IV DX has enhancements which make it more compatible with automated test systems:

Built-in auto-answer phone modem – a modular phone connector is provided on the SAM IV DX rear panel, making possible remote communication and measurement. The modem (300 baud) works the same as a standard phone modem, but is permanently connected to the SAM IV DX and is used only for communication with the instrument. The modular phone connector is connected to a standard phone outlet and will answer the phone. Communication protocol is discussed in the programming section of the manual.

47 MHz crystal controlled calibrator – This calibrator, which has a level of +10 dBmV is internally combined with the incoming signals. This serves as a reference for automated measurements. Although it is not necessary for instrument calibration, the standard 150 MHz calibrator is still accessable from the SAM IV DX front panel as described in the manual. The 47 MHz calibrator is combined internally; therefore, it is automatically measured when the meter is tuned to that frequency (no external connection is required).

Enhanced Peak Detector – The SAM IV DX has a peak detector which has been modified to improve measurement accuracy on video carriers that utilize horizontal sync suppression scrambling techniques.

CAL SET CONTROL MODIFICATION

Differences in meter readings of up to 5 dB between the SAM IV DX and the Remote Terminal have been noted. The following modification has been performed to solve the problem. In the past the Cal Set Control potentiometer had no effect upon the Remote Terminal. With this modification the Cal Set Control potentiometer controls the signal level reading on both the SAM and the Remote Terminal. This greatly reduces the need for a complete recalibration due to the effects of temperature and aging. When the SAM IV DX and the RT are used in conjunction with the AutoBite system, the message "SAM Out of Cal" will no longer be encountered.

INTRODUCTION

This section describes procedures for making several system tests required by FCC regulations. These tests are required annually for CATV systems with 1000 or more subscribers on a headend-count basis. An additional requirement is that the system operator maintain a file containing:

Current FCC Technical Regulations (76.605)
A list of equipment used for testing.
A copy of testing procedures used.
A list of personnel making the tests and their qualifications.
Recorded test results.

The system tests must be performed at at least three locations in the system, one of which must be representative of the point farthest from the headend (longest amplifier run plus cascade).

System test results which change over a period of time can be an indication of problems to come. Comparison of test results with past results can often allow the system operator to detect and correct a malfunction before it becomes a total failure. It is recommended that signal level, hum modulation, and signal-to-noise (S/N) ratio checks be made monthly, as the small amount of time invested in these checks can save a large amount of repair time (not to mention system down time) later.

The procedures for making the following tests should be read and understood completely before beginning the tests. While the order of the tests themselves is not significant, the order of the procedures given within each test should be followed.

NOTE

All tests can be performed using Models SAM IV, SAM IIID, SAM III, and SAM I with Analyzer. Model SAM I without Analyzer can be used for all except response-type tests. Model SAM JR is designed only for signal level-type tests.

SIGNAL LEVEL

SPECIFICATION

$\geqslant$ 0 dBmV at subscriber drop with $\leqslant$ 3 dB difference between adjacent video carriers and $\leqslant$ 12 dB difference between greatest- and least-amplitude video carriers in system. 15 ± 2 dB difference between video and audio carriers on each channel.

A signal level meter (SLM) is essentially a frequency-tuned voltmeter. Signal level is measured at specific frequencies of interest, and typically expressed in dBmV (decibel referenced to 1 mV; i.e., 0 dBmV = 1 mVRMS into 75 Ω = 0.0133 μW). The difference between two signal levels is expressed in dB (e.g., the difference between +5 dBmV and -7 dBmV is 12 dB).

The dB function is a logarithmic ratio. For every 6 dB signal level change, the RMS voltage of that signal changes by a factor of 2, and for every 20 dB signal level change, the RMS voltage of that signal changes by a factor of 10. (See the table at the rear of this handbook.) The dB function is used because it is a convenient method of referring to widely varying signal levels and expressing the difference between them.

PROCEDURE

Turn on the POWER switch and calibrate the calibrate the SAM (refer to the Operating Notes section). Set the front-panel controls as follows:

(SAM IV, SAM IIID, SAM III, SAM I)

FUNCTION	SLM
GAIN	CAL
AUDIO	as desired
AFC	up
S/N	down
ATTENUATOR	+25, +35 in METER windows
LIGHT	as desired
All others	N/A

(SAM JR)

ATTENUATOR	all IN
VOLUME	as desired
CHK BATT	down

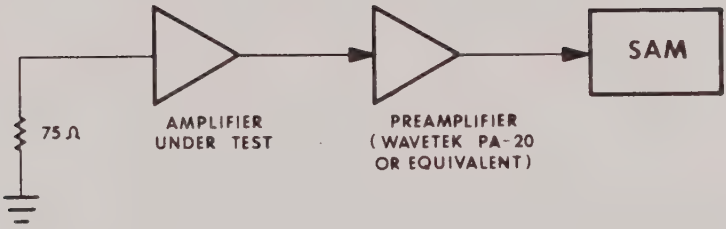


Figure 7. Amplifier Relative S/N Test Set-up

Connect the system signal to the RF IN connector. Select the tuning frequency of interest (refer to the Operating Notes section). Vary the ATTENUATOR control setting until the METER reads on scale. Read the signal level in dBmV.

NOTE

The SAM audio circuit can be a significant aid in finding signals when tuning manually, as it will generally indicate the presence of a signal before the METER gives indication.

SIGNAL-TO-NOISE

SPECIFICATION — > 36 dB (peak signal to system noise, 4 MHz bandwidth); typically > 40 dB

There are three main sources of noise; system amplifiers, headend processors, and interference from external sources. Noise due to system amplifiers will generally be quite flat, varying only slightly across the entire spectrum. Headend noise is typically frequency selective, occurring only in the processor output band. External interference can occur at any frequency, depending on the external source generating the noise.

Noise from system amplifiers can be thought of as an infinite number of low-level carriers throughout the amplifiers' frequency range. Each amplifier adds some noise, but noise does not always add directly, as the low-level carriers are not necessarily the same levels at the same frequencies. Since it is impractical to increase signal level, the noise level must be reduced in order to improve the signal-to-noise ratio. System amplifier noise can often be reduced for the entire system by selecting/testing/sorting amplifiers. Generally, it is better to place the least noisy amplifiers closest to the headend, as most of the signal degradation due to system amplifier noise occurs in the first few amplifiers of a cascade. For example, in a 32-amplifier cascade, typically 40% of the signal degradation due to system amplifier noise occurs in the first four amplifiers. Figure 7 shows a simple test set-up for testing the relative (not absolute) noise levels of various amplifiers to determine the optimum amplifier positioning in the system. The test amplifiers must all be set for the same gain. The test amplifiers which produce the lowest SLM reading have the lowest noise levels. This set-up can be maintained as a permanent reference fixture for checking new and repaired amplifiers.

Two separate tests are performed one for the system itself and one for the headend. The offset or carrier-to-noise method is used.

SYSTEM TEST PROCEDURE

Measure and record the signal level of the video carrier on the lowest-frequency channel in the system (refer to the Signal Level System Test Procedure). The level should be > 20 dBmV.

NOTE

If sufficient level is not available, amplify the signal using a low-noise amplifier, Wavetek PA-20 or equivalent.

With the AUDIO on and adjusted for the desired volume, set the SAM tuning frequency to ~50 MHz. Adjust the ATTENUATOR control to produce a METER range ~50 dB below the recorded signal level. The METER should read on-scale. Fine tune the SAM tuning frequency to produce the minimum METER reading. The audio output should be a "hiss" with no sync "buzz" or indication of a beat or spurious signal. Hold the S/N switch in its up position and record the noise level. Take the difference between the two recorded levels to determine the signal-to-noise ratio.

NOTE

The S/N circuitry automatically compensates for 4 MHz bandwidth and average power.

Repeat this check on channels 7, 13, and any other desired channel. Be sure to find a vacant area in the spectrum for the noise level check.

HEADEND TEST PROCEDURE

The headend test is somewhat more complex. Before it is performed, the system test should be performed to see if the headend test is needed.

Signal-to-noise ratios of < 40 dB will result in a degradation of the subscriber's picture quality. A good quick check is to connect a television receiver and check picture quality. If the picture quality is good on all channels, the headend test is not needed. If the picture quality is not good enough on some or all channels, perform the headend test on those channels.

Connect the headend processor output to the SAM RF IN connector and measure and record the processor output level. Disable the processor AGC and

manually set the processor output level to the level previously measured. Disconnect the processor input signal and terminate the processor input. Adjust the SAM ATTENUATOR control until an on-scale METER reading is obtained. Fine tune the SAM tuning frequency to produce the minimum METER reading. Hold the S/N switch in its up position and record the noise level. Take the difference between the two recorded levels to determine the processor's signal-to-noise ratio.

HUM MODULATION

SPECIFICATION $< 5\%$ pp; typically $< 2\%$ pp

Hum modulation (low-frequency disturbances) is essentially low-frequency amplitude modulation caused by the interaction of system signals with system AC power sources. The most common cause of hum modulation is a defective amplifier power supply. This can produce an AC ripple component on the amplifier's DC supply, thus causing hum modulation. (This can also indicate impending failure of the power supply.) Corroded connections on couplers, taps, splitters, etc. can also be a source of hum modulation, as the corrosion acts as a mixer diode for the AC and system signals. Typically, this modulation is present at frequencies below 300 Hz. The hum modulation circuitry in the SAM will measure hum modulation up to 500 Hz.

Since television signals are amplitude modulated, the hum modulation test should be performed on an unmodulated (pilot) carrier or a signal inserted for test purposes. Hum modulation is generally not frequency-dependent; therefore, the test need be performed at only one frequency.

SYSTEM TEST PROCEDURE

Set the SAM controls as though measuring signal level and connect the system signal to the RF IN connector. Set the SAM tuning frequency to an unmodulated carrier or test signal (use the TUNING control on Models SAM IV, IIID, and III to avoid digital spike interference). Set the ATTENUATOR control such that the METER reads to the right of mid-scale, but is not pegged. Set the FUNCTION switch to HUM. The METER may peg momentarily, but will then indicate the correct hum modulation reading.

PERCENT MODULATION

The percent modulation test is an operating check for modulators. Modulators used for local origination or translation of incoming signals can change the modulation depth of a video signal, and both under- and over-modulation can degrade the picture quality. This check uses the SAM as a receiver/demodulator, with an oscilloscope as the readout device.

TEST PROCEDURE

Connect the SAM VIDEO or VIDEO/VERT connector to the vertical input of an oscilloscope. (Do not use the built-in CRT display on Model SAM IV.) Set the oscilloscope's vertical sensitivity for 100 mV/division, DC coupled. Set the oscilloscope's horizontal time base for 5 msec/division, external sync.

NOTE

Some oscilloscopes do not synchronize well on a composite video signal. If this is the case, set the oscilloscope for line sync and let the trace "crawl" slowly across the display.

Connect the signal to be measured to the SAM RF IN connector and measure the level of the signal being tested. Adjust the ATTENUATOR control such that the METER reads in the upper portion of the scale.

Ground the oscilloscope's vertical input (or remove the input from the SAM) and adjust the oscilloscope's vertical position control such that the trace coincides with the bottom graticule line. Unground the oscilloscope's vertical input (or reconnect the input from the SAM) and adjust the oscilloscope's vertical sensitivity vernier control such that the sync peak of the video signal is exactly eight divisions above the bottom graticule line (see Figure 8). This establishes the 0% and 100% modulation reference levels (12.5%/division).

NOTE

The oscilloscope controls may interact, so repeat the above procedure until the two reference levels are established without further adjustment of the oscilloscope controls.

Refer to Figure 9. The downward-going spike immediately to the right of the sync pulse is a modulation test flag. This test flag should extend downward to exactly one division above the bottom graticule line. (This corresponds to 87.5% modulation.) If the flag does not show the correct modulation depth, adjust the modulator accordingly.

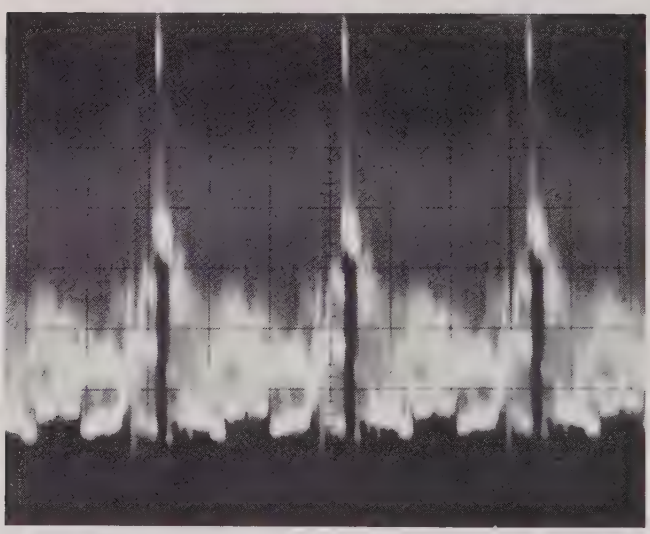


Figure 8. Percent Modulation Reference

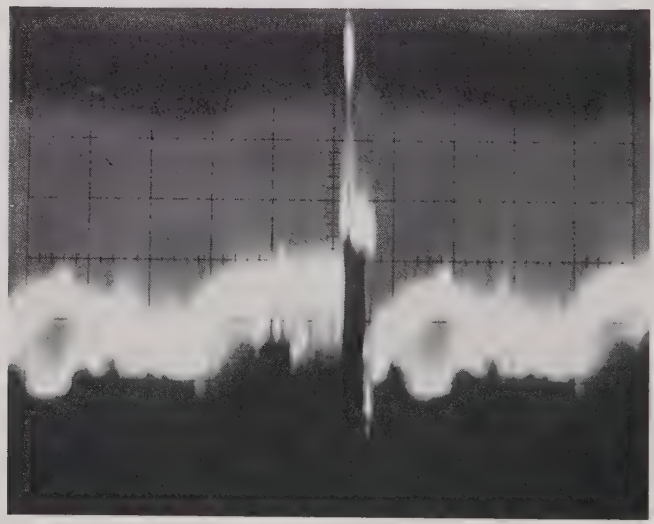


Figure 9. Percent Modulation Measurement

FREQUENCY ACCURACY

SPECIFICATIONS

Video Carrier $\leqslant \pm 25$ kHz
Audio-Video Separation $4.5 \pm .001$ MHz

Generally, frequency counters will not accurately measure video modulated signals. The zero-beat (using the SAM's internal detector as a mixer to obtain the difference frequency) technique described below enables measurement of the audio and video carriers using a frequency counter (Wavetek Model CM-1000 or equivalent) and a signal generator (Wavetek Model 1801B, MC-50, or equivalent).

System locations where frequency accuracy problems are most likely to occur include modulators (most likely), UHF/VHF converters, and off-channel converters. (With converters, the audio-video separation is generally within specification, but the video carrier may be off-frequency.) Network signals are almost never out of specification.

VIDEO TEST PROCEDURE

Connect the equipment as shown in Figure 10 and allow sufficient warm-up time for the equipment to stabilize.

NOTE

If the signal generator does not have an auxiliary output, use an appropriate splitter at the signal generator's RF output connector.

Measure the level of the system signal. Connect the signal generator's RF output to the splitter and set its output level to approximately the same level as the system signal. With the SAM AUDIO on, tune the generator to the system signal frequency. As the signal generator frequency approaches the system signal frequency, an audible tone decreasing in frequency will be heard. (The frequency of this tone is the difference between the system signal and the signal generator output frequencies.) Slowly vary the signal generator frequency until the difference frequency is at minimum (ideally zero). The frequency counter now indicates the frequency of both the signal generator and system signals.

AUDIO-VIDEO (INTERCARRIER) TEST PROCEDURE

One method of determining the audio-video separation is to perform the Video Test Procedure on both the audio and video carriers and taking the difference between their frequencies. Another method utilizes a demodulator with a 4.5 MHz output and a set-top converter.

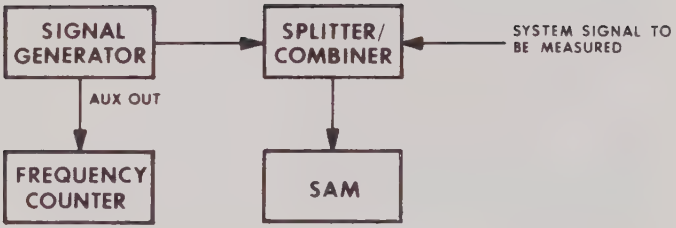


Figure 10. Frequency Accuracy Test Set-up 1

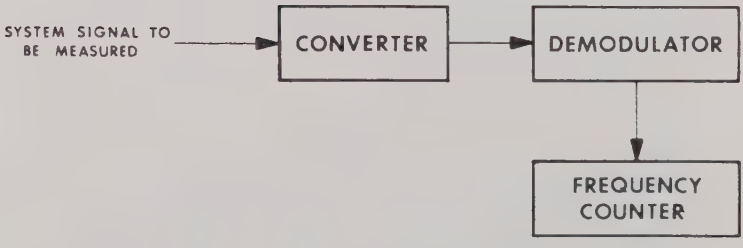


Figure 11. Frequency Accuracy Test Set-up 2

To use the second method, connect the equipment as shown in Figure 11. The audio-video separation of the channel selected by the converter is displayed on the frequency counter.

NOTE

An alternate method of determining frequency accuracy is to use a Wavetek Model SP-2 signal processor. This instrument removes the video modulation, thus allowing a direct frequency counter reading of the video carrier frequency, and also has a 4.5 MHz output for measuring the audio-video separation.

SYSTEM RESPONSE (FLATNESS)

SPECIFICATION — ⩽12 dB variance throughout the system frequency range.

System response (flatness) is a frequency versus amplitude relationship, and is primarily a function of system components (amplifiers, taps, connectors, cable, etc.). There are many techniques for measuring system response. The Wavetek Model 1855/1865 Sweep Recovery System performs this measurement extremely well. If it is not available, the SAM (with Analyzer) can perform this measurement using the sweep/spectrum analyzer technique.

NOTE

Some subscriber interference may be noticed while perfroming this measurement; however, the interference is generally tolerable and short-lived.

System response problems can take many forms. Notching (a sharp drop or valley in the response) is generally caused by cracked or corroded fittings. Ringing (a sinewave superimposed on the response) usually indicates high VSWR caused by bad connectors or cable. (A notable feature about ringing is that the closer the test point is to the source of the ringing, the lower in frequency and greater in amplitude the sine wave becomes.) Tilt (a steady decrease in amplitude with frequency) is generally caused by a bad amplifier or cable. Poor signature response (amplifier characteristics) is the most difficult to correct, as it may mean replacing or realigning one or more of the amplifiers in the cascade.

SYSTEM RESPONSE TEST PROCEDURE

Using a sweep generator (Wavetek Model 1801B or equivalent) at a slow sweep rate, a signal 20 dB below the video carrier level will be inserted at a point after all signals are combined (see Figure 12). To do this, first measure and record the

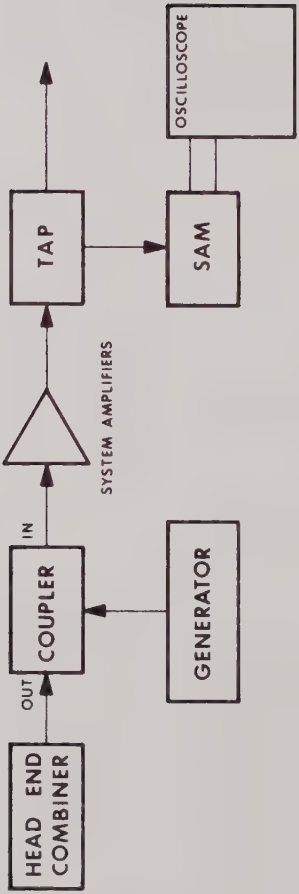


Figure 12. System Response Test Set-up

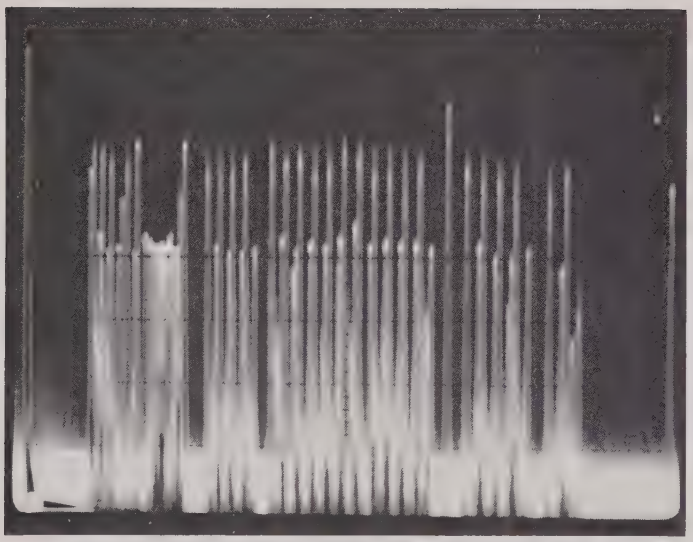


Figure 13. System Response Display 1

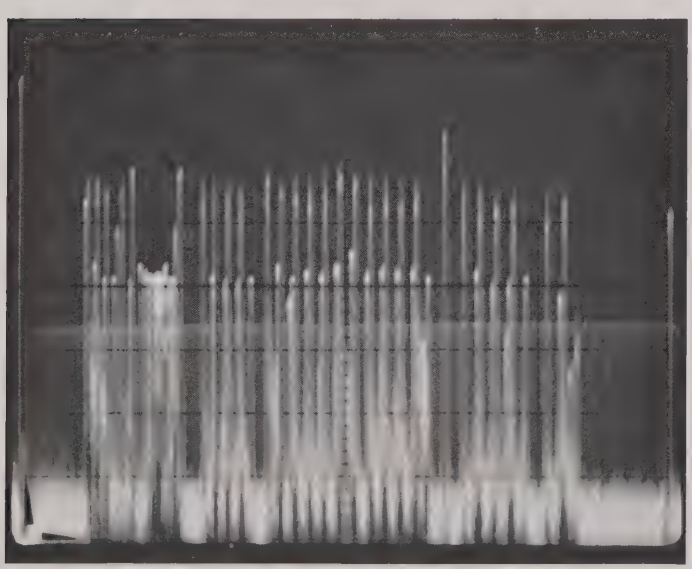


Figure 14. System Response Display 2

video carrier levels of channels 2, 6, 7, 13, and the highest frequency channel on the system. (Be sure to compensate for the directional tap used at the test point.)

Connect an oscilloscope to the SAM HORIZ and VIDEO/VERT connectors (use the built-in display on Model SAM IV) and set the SAM FUNCTION switch to ANALYZER. Set the SAM analyzer controls such that the entire analyzer frequency range and a 40 dB amplitude range are displayed on the oscilloscope (refer to the Analyzer section of this handbook). Connect the tap to the SAM RF IN connector. The oscilloscope display should appear similar to Figure 13.

Using a splitter, connect a CW test signal from the sweep generator (at a level 20 dB below the system carrier levels, and at an unused frequency in the spectrum such as 150 MHz) to the SAM RF IN connector along with the system signals. Identify the signal from the sweep generator. Set the sweep generator to sweep very slowly across the system frequency spectrum. The test signal trace should move slowly from left to right on the display.

NOTE

Since the sweep generator and analyzer sweeps are not synchronized, and many sweep generators have a retrace blanking circuit which turns the output off 50% of the time, the test signal trace may not appear immediately. If this occurs, vary the sweep generator rate until the test signal trace appears.

Narrow the analyzer dispersion to display just the system frequency spectrum, and reduce the sweep generator sweep width to sweep just the system frequency range.

Disconnect the sweep generator from the splitter and connect it through a coupler into the system. Set the sweep generator output level ~20 dB below the system video carrier levels (be sure to compensate for the coupler). Remove the splitter and connect the system test point to the SAM RF IN connector. The display should appear similar to Figure 14.

NOTE

Due to the sampling action of the analyzer, the test trace will appear as a series of traces rather than as one continuous sweep.

Connect the SAM to system test points in the field. The oscilloscope display should remain similar to Figure 14. The level of the test trace should not vary

more than 12 dB (highest to lowest throughout the spectrum. If there is significant difference, systematically select test points closer to the headend until the source of the difference is found and corrected.

CHANNEL RESPONSE (FLATNESS)

SPECIFICATION	$\leqslant \pm$ 2 dB variation from -0.5 to +3.75 MHz (referenced to video carrier frequency)

The specification indicates that the response level throughout the range of from 0.5 MHz below the video carrier frequency to 3.75 MHz above the video carrier frequency cannot vary more than 2 dB from the response level at the video carrier frequency.

NOTE

System response (flatness) has essentially no effect on channel response.

TEST PROCEDURE

In this procedure, the system is tested under normal operating conditions. A signal $\sim$25 dB below the video carrier is inserted and the response measured on the SAM analyzer.

Connect the equipment as shown in Figure 15. (Note that the 20 dB coupler is installed backwards.) The tap (or taps) should be a high value ($\geqslant$ 20 dB) to provide low insertion loss for the test signal. Set the SAM ATTENUATOR, tuning frequency, and analyzer controls to display the channel of interest on the oscilloscope (or the SAM IV display). (Refer to the Analyzer and System Response (Flatness) sections for analyzer set-up.) The oscilloscope display should appear similar to Figure 16. Adjust the SAM DISP control such that the video and audio carriers are exactly 9 divisions apart on the oscilloscope graticule. This calibrates the horizontal graticule at 0.5 MHz/division (4.5 MHz/9 divisions).

Use the following procedure to calibrate the vertical graticule. Set the SAM FUNCTION switch to SLM. Measure the level of the channel of interest's video carrier (set the SAM ATTENUATOR control such that the METER reads in the middle of its range). Set the SAM FUNCTION switch to ANALYZER and adjust the oscilloscope vertical position control such that the video carrier peak touches the top graticule line. Increase the SAM ATTENUATOR control setting by 20 dB and adjust the oscilloscope vertical gain control such that the video carrier

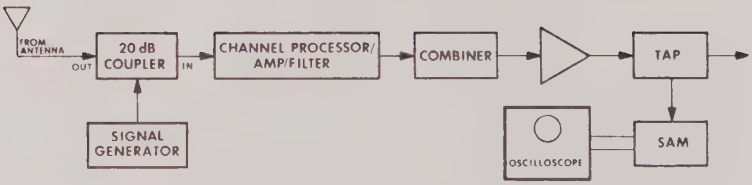


Figure 15. Channel Response Test Set-up

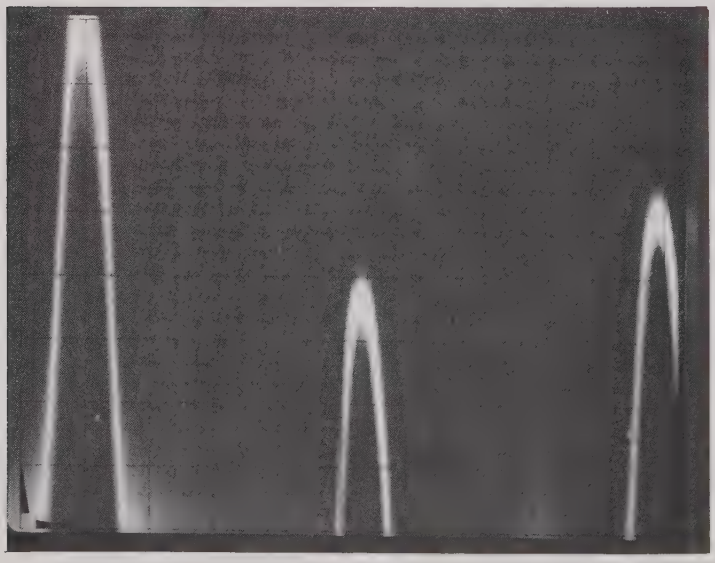


Figure 16. Channel Response Display

peak is exactly five divisions below the top graticule line. (The oscilloscope vertical gain and position controls may interact, so repeat these adjustments until the five division change is accomplished with no further adjustments needed.) The vertical graticule is now calibrated at 4 dB/division (20 dB/5 divisions).

Decrease the SAM ATTENUATOR control setting by 10 dB. This should cause the video carrier peak on the display to go off-screen to the top and the audio carrier to rise to approximately mid-scale.

With the signal generator (Wavetek Model 1801B, MC-50, or equivalent), insert a CW signal into the coupler approximately 5 dB below the video carrier level. (Since the coupler will reduce this signal by 20 dB, the resulting test signal will be approximately 25 dB below the video carrier level.) Set the signal generator frequency as close as possible to the video carrier frequency without losing the test signal trace in the video carrier response trace. For convenience, adjust the test signal level such that the test signal trace peak falls on a graticule line. This graticule line becomes a reference line. Set the signal generator frequency to 0.5 MHz (one division) below the video carrier frequency. Now slowly tune the signal generator from 0.5 MHz below the video carrier frequency to 3.75 MHz (7½ divisions) above the video carrier frequency. The test signal trace level must not vary from the reference line by more than ½ division (2 dB) at any point.

RADIATION

SPECIFICATION	$< 20\ \mu V/m$ at 10 ft; typically $< 2\ \mu V/m$ (Systems carrying signals in the 108 to 136 MHz and/or the 220 to 270 MHz range may be subject to additional patrolling and recording requirements.)

Generally, problem radiation emanates from loose, broken, or defective housings, connectors, couplings, etc., and is typically $> 100\ \mu V/m$ at 10 feet. Occasionally, guy wires, grounds on poles, and other cables can re-radiate leaks, especially if the re-radiating item is within 10 feet of the leaking cable. Radiation problems are generally detected by patrolling the system with an FM receiver (tuned to a test signal on an unused frequency) installed in the patrolling vehicle. The Wavetek Models ST-1C/CR1b are designed specifically for this purpose. An alternate patrolling set-up consists of dipole antenna and preamplifier (Wavetek Model RD-1 or equivalent) feeding a signal level meter (any of the Wavetek SAM Series) as a receiver, with the test signal being generated by a transmitter (Wavetek Model ST-1 or equivalent) at the headend. Refer to the Operating Handbooks for the above Wavetek instruments for additional information.

Patrolling techniques will locate problem radiation. The following procedure details the actual measurement of the radiation. (It is assumed that a dipole antenna and preamplifier — Wavetek Model RD-1 or equivalent — is being used for the measurement.) Adjust the dipole length as required for the channel/frequency of interest. Connect the preamplifier output to the SAM RF IN connector. Set the SAM controls to measure the signal level of the channel/frequency of interest. Position the dipole such that it is 10 feet away from and parallel to the cable. Rotate the dipole in a plane parallel to the cable and note the maximum radiation level reading.

NOTE

It may not always be possible to position the dipole exactly 10 feet away from and parallel to the cable. In such cases, note the circumstances and/or problems on the test data recorded.

Correct the reading for the preamplifier used to obtain the true radiation level reading. This should be in the -40 to -80 dBmV range, depending on the channel/frequency being tested. (The higher the channel/frequency, the lower the permissible radiation level; i.e., the maximum permissible radiation level at channel 2 is -36 dBmV, while at channel 13, the maximum permissible radiation level is -47 dBmV.)

Once the true radiation level is determined, convert the specified level in μV/m to dBmV using the following formulae:

$$M = 20\ \mu V/m = ((0.021 \times F)/1000)\ mV$$

$$L = (20 \log M)\ dBmV$$

Where M is defined as the radiation level in mV, L is defined as the radiation level in dBmV, and F is the frequency of interest in MHz.

For example, at channel 13, F = 211.25 MHz, thus:

$$M = ((0.021 \times 211.25)/1000)\ mV = 0.004436\ mV$$

and $L = (20 \log 0.004436) = -47.06$ dBmV.

Thus the specified maximum radiation level at channel 13 (211.25 MHz) is -47.06 dBmV.

NOTE

If the Wavetek Model RD-1 is used, the preamplifier correction and conversion of the specified levels for channels 2 through I have been calculated and listed in the Model RD-1 Operating Handbook.

RETURN LOSS/VSWR/IMPEDANCE MATCHING

Return loss (usually specified in dB) is the ratio of the original signal to reflected signal at a junction point in a circuit. Typically, this is at a coaxial cable connection to the input or output of a piece of equipment. With a perfect connection (which, of course, does not exist because of impedance mis-matches due to inductive, resistive, and capacitive factors, two of which are frequency-dependent), all the signal is transmitted and none is reflected (return loss = ∞ dB). At the other extreme, if a transmission line (coaxial cable) is terminated in either a short or an open, none of the signal is transmitted and all of it is reflected (return loss = 0 dB). The greater the return loss figure (specified in dB), the better the connection and transmission of the signal through the connection.

The return loss specification describes quality of the connection, and also the deviation of a device input or output from its nominal impedance (75 ohms for CATV applications) as well as the voltage standing-wave ratio (VSWR). (VSWR is itself the ratio of the maximum and minimum voltages on the transmission line created by the interference of the original and reflected signals.)

For example, if a 1 V signal were applied to a device whose input has a return loss specified at 20 dB, the reflected signal will be 20 dB lower than the original signal. Thus, 0.1 V will be reflected and 0.9 V will be transmitted. If the return loss of the device were 40 dB, 0.01 V would be reflected and 0.99 V would be transmitted.

Return loss can be measured with the SAM using a return loss bridge (such as Wavetek Model FB40-75) and a signal generator (Wavetek Model 1801B, MC-50, or equivalent). Connect the equipment as shown in Figure 17. Apply a signal at the desired frequency from the signal generator to the terminated bridge and read the signal level on the SAM. Replace the terminator with the device under test and read the signal level on the SAM. The difference between the two signal levels (in dB) is the return loss.

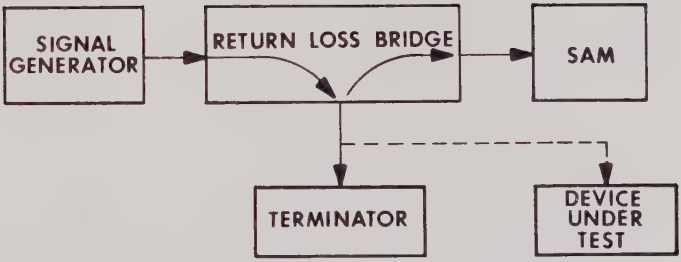


Figure 17. Return Loss Test Set-up

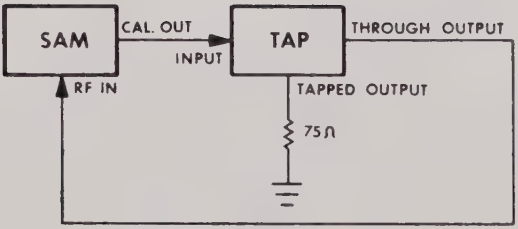


Figure 18a. Through Loss Test Set-up (Tap)

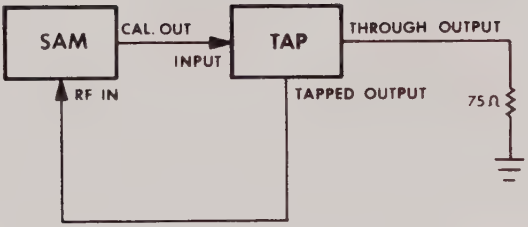


Figure 18b. Tap Loss Test Set-up (Tap)

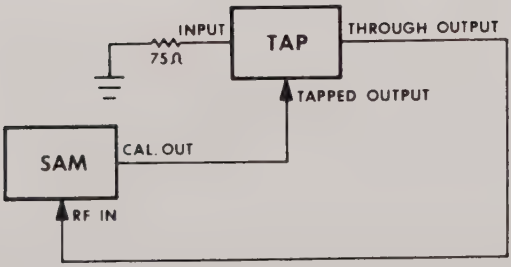


Figure 18c. Isolation Test Set-up (Tap)

TESTING SPLITTERS AND TAPS

The preferred method of testing passive components such as splitters and taps utilizes a sweep generator, RF detector, and oscilloscope; however, an operational check (adequate for most circumstances) can be performed using only a SAM.

The SAM calibrator output (+20 dBmV at 150 MHz) is used as a test signal, with the various parameters of interest being calculated as the difference in level between the calibrator signal and the measured output from the appropriate device port. (Since Model SAM JR has no internal calibrator, a signal generator — Wavetek Model MC-50 or equivalent — is required).

NOTE

If multiple-frequency tests are desired and a suitable sweep/signal generator is not available, the TV channel carriers themselves (coupled through appropriate amplifiers and attenuation pads) can be used as test signals.

TESTING TAPS

There are three significant parameters to test on a tap (broadband directional coupler): through loss (input to through output); tap loss (input to tapped output); and isolation (tapped output to through output). To test through loss, calibrate the SAM and connect the tap to the SAM as shown in Figure 18a. Measure the tap's through output level. The difference between the SAM calibrator level (+20 dBmV) and the through output level (typically $>$ +19 dBmV) is the through loss (typically $<$ 1 dB).

To test tap loss, calibrate the SAM and connect the tap to the SAM as shown in Figure 18b. Measure the tap's tapped output level. The difference between the SAM calibrator level (+20 dBmV) and the tapped output level is the tap loss. (The tap loss should be the nominal value of the tap; i.e., a 20 dB tap should have a tap loss of 20 dB.)

To test isolation, calibrate the SAM and connect the tap to the SAM as shown in Figure 18c. Measure the tap's through output level. The difference between the SAM calibrator level (+20 dBmV) and the through output level is the isolation. Ideally, no signal should reach the through output; however, in practice, the isolation is typically 20 dB plus the tap loss.

TESTING SPLITTERS

The procedures for testing splitters (broadband power dividers) are virtually identical to those for testing taps. The parameters to be measured are through loss (for each "leg" of the splitter) and isolation. Figures 19a and 19b show the test connections for a two-way splitter. Four-way and eight-way splitters are simply multiple two-way splitters in series. A "low-high" splitter will have different attenuation pads in each splitter "leg". The typical through loss for each leg of a two-way splitter is 3.5 dB. For four-way and eight-way splitters, the typical through losses are 7 dB and 11 dB, respectively. Typical isolation between "legs" of a two-way splitter is 20 dB. For four-way and eight-way splitters, the isolation will vary depending on the splitter's internal configuration, but should always be $>$ 20 dB.

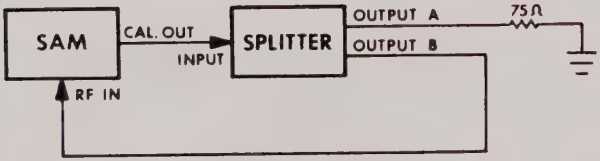


Figure 19a. Through Loss Test Set-up (Splitter)

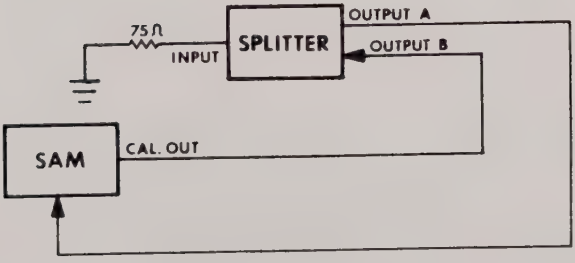


Figure 19b. Isolation Test Set-up (Splitter)

PROGRAMMING – (MODELS SAM IV, IIID)

INTRODUCTION

This section provides information on using Model SAM IV or SAM IIID with an external controller, typically a small computer system. Information is given concerning communication format, commands, system configuration and operation, programs, and tests which can be performed.

COMMUNICATION

Models SAM IV and SAM IIID communicate asynchronously (synchronization is included in the character information) with external devices. Each character consists of 10 bits: one "start" bit; two "stop" bits; seven character code (ASCII) bits; and no parity bits (refer to Figure 20). Some systems may require two "stop" bits and even parity (IBM and Compaq). The data transfer rate is 300 baud (300 bits/second), or 30 characters/second.

COMMANDS

A list of programming commands used by Models SAM IV and SAM IIID is given in Table 1. Each command, its function, and its operation will be explained individually.

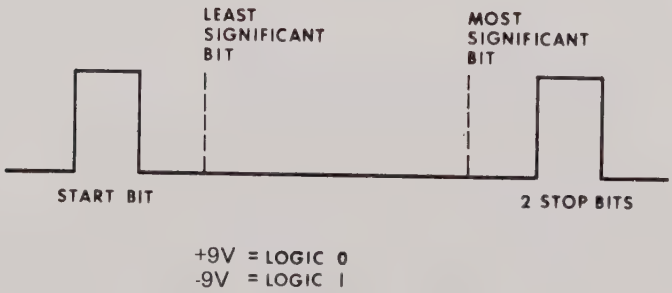


Figure 20. Data Communication Format

Table 1. Program Commands

Command	Hex Equivalent	Comments
F	46	Initialize SAM input buffer.
A CR	41 0D	Note SAM ATTENUATOR control setting.
B CR	44 0D	Measure SAM battery (power supply) voltage.
H CR	48 0D	Measure hum modulation.
S CR	53 0D	Measure signal level.
T CR	54 0D	Measure temperature.
Linefeed	0A	Non-functional.
0-9 CR	30-39 0D	Any set of one to four digits followed by a carriage return will be interpereted by the SAM as a desired tuning frequency in MHz. (The last digit sent will be interpereted as tenths of MHz.) The SAM will lock (or attempt to lock) on this frequency. If more than four digits are sent prior to the carriage return, the SAM will use only the last four as its command.

CR = Carriage return.

Hex Equivalent = Hexadecimal (base 16) ASCII code for the alphanumeric command or data.

After each command, the SAM will respond with a number showing execution of the command. The responses are explained in the following sections.

F COMMAND

The F command initializes the instrument's internal buffer. Since noise on the data transmission line can be interpereted as a character, it is recommended to use the F command prior to any other command.

A COMMAND

The A command inquires of the instrument the ATTENUATOR control setting. The instrument will answer with a three-digit number which is indicative of the control setting as follows:

ATTENUATOR Setting (dBmV)	Response	Hex Equivalent		
-25 to -15	144	31	34	34
-15 to - 5	160	31	36	30
- 5 to 5	176	31	37	36
5 to 15	192	31	39	32
15 to 25	208	32	30	38
25 to 35	223	32	32	33
35 to 45	239	32	33	39
45 to 55	255	32	35	35

The ATTENUATOR setting is required for determining the actual signal level using the S command.

B COMMAND

The B command inquires of the Model SAM IIID the current battery voltage.

The instrument will respond with a three-digit number which is indicative of the voltage as follows:

Voltage (VDC)	Response	Hex Equivalent		
16.00	156	31	35	36
15.50	151	31	35	31
15.00	147	31	34	37
14.50	142	31	34	32
14.00	137	31	33	37
13.50	133	31	33	33

Voltage (VDC)	Response	Hex Equivalent		
13.00	128	31	32	38
12.50	124	31	32	34
12.00	119	31	31	39
11.50	115	31	31	35
11.00	110	31	31	30

(Voltage = ((0.1087 x response) -0.957) volts)

If the battery is sufficiently changed, the response should be a number > 127. The battery voltage should be checked at the start of each usage.

NOTE

On Model SAM IV, the B command will inquire the power supply voltage, which should be a constant 13.0 to 13.5 VDC.

H COMMAND

The H command will cause the SAM to measure hum modulation. The instrument will respond with a three-digit number which is indicative of the modulation as follows:

Hum Modulation (%)	Response	Hex Equivalent		
1	011	30	31	31
2	032	30	33	32
3	054	30	35	34
4	076	30	37	36
5	097	30	39	37

(Hum modulation = ((0.0465 x response) + 0.49)%)

S COMMAND

The S command will cause the SAM to measure signal level. The instrument will respond with a three-digit number which is indicative of the signal level as follows:

(Signal Level = ((0.303 x response) -38.78 dB)

The values given in the table below are an example of the response from the SAM when the S command is given. The actual responses may vary. It is recommended that the equation be used to determine signal level based on the response from the SAM.

NOTE

The values given below are referenced to the center of the level range selected by the ATTENUATOR control. The measurement range is ~30 dB, ~15 dB above and below the range center value. The ATTENUATOR control setting must be known in order to determine the absolute signal level. Use the A command to determine the ATTENUATOR control setting.

Signal Level (dB)	Response	Hex Equivalent		
- 15	077	30	37	37
- 14	081	30	38	31
- 13	084	30	38	34
- 12	087	30	38	37
- 11	091	30	39	31
- 10	094	30	39	34
- 9	097	30	39	37
- 8	101	31	30	31
- 7	104	31	30	34
- 6	107	31	30	37
- 5 (Left METER Window Value)	110	31	31	30
- 4	114	31	31	34
- 3	117	31	31	37
- 2	120	31	32	30
- 1	124	31	32	34
0 (METER Center Scale Value)	127	31	32	37
+ 1	130	31	33	30
+ 2	134	31	33	34
+ 3	137	31	33	37
+ 4	140	31	34	30
+ 5 (Right METER Window Value)	143	31	34	33
+ 6	147	31	34	37
+ 7	150	31	35	30
+ 8	153	31	35	33
+ 9	157	31	35	37
+10	160	31	36	30
+11	163	31	36	33
+12	167	31	36	37
+13	170	31	37	30
+14	173	31	37	33
+15	177	31	37	37

Signal level = ((0.303 x response) - 38.48) dB)

T COMMAND

The T command will cause the SAM to measure the ambient temperature. The instrument will respond with a three-digit number which is indicative of the signal level as follows:

Temperature (°C)	Response	Hex Equivalent
45	224	32 32 34
40	206	32 30 36
35	188	31 38 38
30	170	31 37 30
25	153	31 35 33
20	135	31 33 35
15	118	31 31 38
10	100	31 30 30
5	082	30 38 32
0	065	30 36 35
- 5	047	30 34 37
-10	030	30 33 30

(Temperature = ((0.284 x response) -18.4) °C)

FREQUENCY SELECTION

Any one-to-four-digit number followed by a carriage return applied to the SAM will select that tuning frequency in MHz (the last digit sent will be considered as to the right of the decimal point). The number sent will be "echoed" for verification, and approximately two seconds later the SAM will "lock" onto that tuning frequency. Once the SAM has "locked" onto frequency, any of the measurement commands may be initiated.

Examples:

Tuning Frequency	Digits Sent	Hex Equivalent
8.7 MHz	8 7 CR	38 37 0D
96.0 MHz	9 6 0 CR	39 36 30 0D
214.3 MHz	2 1 4 3 CR	32 31 34 33 0D

The digit to the right of the decimal point must be sent (even if it is zero). The decimal point itself must not be sent.

REMOTE OPERATION SAMPLE

Following is a sample sequence showing the commands sent to the SAM and the responses from the SAM.

Command	Hex Equivalent	Response	Hex Equivalent	Comments
F B CR	46 44 0D	158 CR	31 35 38 0D	Battery/Power Supply Level OK
F A CR	46 41 0D	144 CR	31 34 34 0D	ATTENUATOR control set to +15 to +25 dBmV range. Data saved.
F 1 5 0 0 CR	46 31 35 30 30 0D	1500 CR	46 31 35 30 30 0D	Tuning Frequency is set to 150.0 MHz. If response is not 1500, repeat.
F S CR	46 53 0D	120 CR	31 32 30 0D	Measured signal level is +18 dBmV. Use difference between +18 and +20 dBmV (2 dB) as calibration constant.
F T CR	46 54 0D	170 CR	31 37 30 0D	Temperature is 30° C.
F 9 6 6 CR	46 39 36 36 0D	966 CR	39 36 36 0D	Tuning Frequency is 96.6 MHz.
F S CR	46 53 0D	107 CR	31 30 37 0D	Measured signal level is +9 dBmV. Adjust this by the calibration constant (2 dB) to determine the actual signal level (+11 dB).
F H CR	46 48 0D	032 CR	30 33 32 0D	Hum modulation is 2%.

NOTE

Over long periods of operation, temperature, ATTENUATOR control setting, and battery level (Model SAM IIID) should be checked intermittently.

SPECIAL PROGRAMMING NOTES

Power is automatically applied to the SAM when electrical connection is made to the computer. Power can be removed only by breaking the electrical connection (typically by deactivating a MODEM). Power is not applied to the CRT display on Model SAM IV. To use the CRT display, the front-panel POWER switch must be switched on.

24 HOUR TEST

This test verifies the FCC specification that there be no more than 12 dB variation on any carrier within a 24 hour period. This test is easily performed with Model SAM IV or SAM IIID, as the controlling computer can be programmed to perform the signal level checks at regular intervals, with the results being printed and/or stored on diskette.

SAM RS232 CONNECTOR PIN–OUTS

PIN #

2 ——— Data Send (from SAM)

3 ——— Data Receive (to SAM)

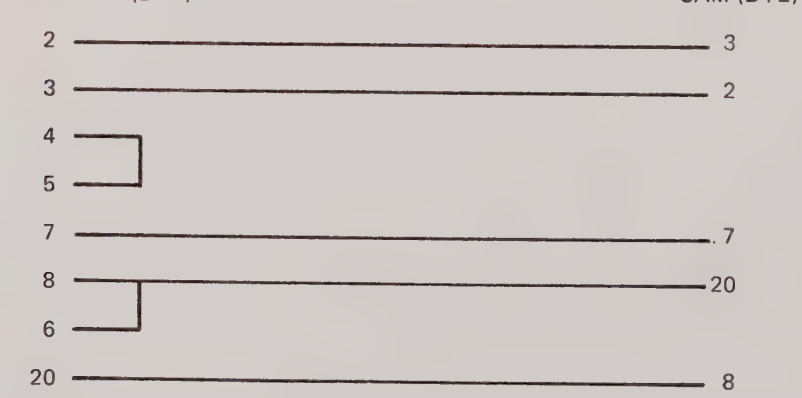
7 ——— Signal Ground

8 ——— Remote Enable (apply +5 VDC to turn on SAM remotely)

20 ——— Data Terminal Ready

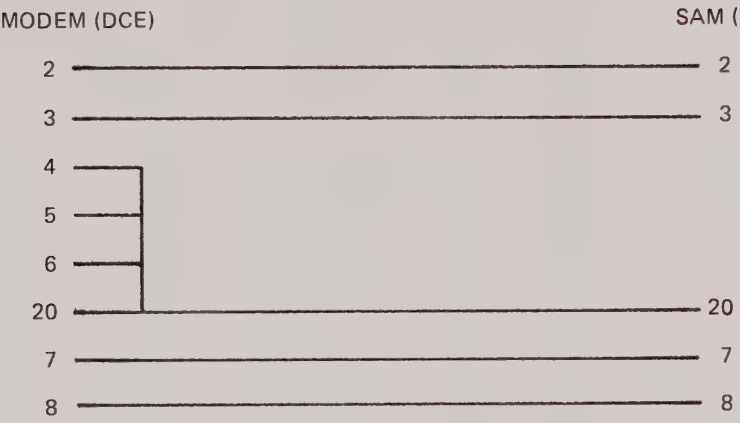
HOW TO WIRE A NULL MODEM CONNECTION

There are some circumstances in which it is desirable to make a direct connection between an RS232 accessable SAM and a dumb terminal. The drawing below shows the wiring required to make this connection.



NOTE: If the terminal is DCE the wiring is the same except pin 2 connects to pin 2, and pin 3 connects to pin 3.

For a modem to SAM connection:



AUTOBITE

Many different programs have been written by end users for SAM RS232 controllable meters. For those who would like to save themselves the time it takes to write a good system program, and would like to have a system that exercises the SAM's full capabilities, Wavetek's AutoBite system is available. The AutoBite system consists of a controlling IBM PC compatible computer (Compaq), a printer (Epson LX–80), and the software. The software can be purchased separately, to be implemented on existing IBM PC hardware with the following:

1. 1 disk drive
2. 256K RAM
3. Run Basic version 2.1 up, and graphics capability
4. I/O Plus II RS232, clock from AST Research (in com port 1)
5. Hayes Smartmodem 300 or compatible modem (com port 2)
6. Epson LX–80 or compatible printer with interface cable

The AutoBite system consists of three different types of tests; manual, semi-automatic, and automatic. In the manual mode the operator can use the computer to call a site and perform tests of temperature, attenuator setting, and auto-calibration, and also perform measurements (one carrier at a time) of signal level and hum percentage. In the automatic mode the controlling computer will call specific sites at different times throughout the day, and perform the measurements prescribed by the operator which have been tailored to each site's requirements. The semi-automatic mode allows the operator to initiate a test at any site, and the controlling computer will perform a test automatically.

CHANNEL CARRIER FREQUENCIES

CHAN	CVTR NO.	STD VIDEO (MHz)	HRC VIDEO (MHz)	CHAN	CVTR NO.	STD VIDEO (MHz)	HRC VIDEO (MHz)
2	2	55.25	54.00	M	26	235.25	234.00
3	3	61.25	60.00	N	27	241.25	240.00
4	4	67.25	66.00	O	28	247.25	246.00
4+	**	****	72.00	P	29	253.25	252.00
5	5	77.25	****	Q	30	259.25	258.00
5+	**	****	78.00	R	31	265.25	264.00
6	6	83.25	****	S	32	271.25	270.00
6+	**	****	84.00	T	33	277.25	276.00
7	7	175.25	174.00	U	34	283.25	282.00
8	8	181.25	180.00	V	35	289.25	288.00
9	9	187.25	186.00	W	36	295.25	294.00
10	10	193.25	192.00	AA	37	301.25	300.00
11	11	199.25	198.00	BB	38	307.25	306.00
12	12	205.25	204.00	CC	39	313.25	312.00
13	13	211.25	210.00	DD	40	319.25	318.00
A-8	**	73.25	72.00	EE	41	325.25	324.00
A-7	**	79.25	78.00	FF	42	331.25	330.00
A-6	**	85.25	84.00	GG	43	337.25	336.00
A-5	**	91.25	90.00	HH	44	343.25	342.00
A-4	**	97.25	96.00	II	45	349.25	348.00
A-3	**	103.25	102.00	JJ	46	355.25	354.00
A-2	**	109.25	108.00	KK	47	361.25	360.00
A-1	**	115.25	114.00	LL	48	367.25	366.00
A	14	121.25	120.00	MM	49	373.25	372.00
B	15	127.25	126.00	NN	50	379.25	378.00
C	16	133.25	132.00	OO	51	385.25	384.00
D	17	139.25	138.00	PP	52	391.25	390.00
E	18	145.25	144.00	QQ	53	397.25	396.00
F	19	151.25	150.00	RR	54	403.25	402.00
G	20	157.25	156.00	SS	55	409.25	408.00
H	21	163.25	162.00	TT	56	415.25	414.00
I	22	169.25	168.00	UU	57	421.25	420.00
J	23	217.25	216.00	VV	58	427.25	426.00
K	24	223.25	222.00	WW	59	433.25	432.00
L	25	229.25	228.00	XX	60	439.25	438.00

NOTE: If HRC channel 5 or 6 is selected via the SAM keyboard, the HRC channel 5+ or 6+ frequency will be tuned.

CHANNEL CARRIER FREQUENCIES (CONTINUED)

CHANNEL	STD VIDEO (MHz)	CHANNEL	STD VIDEO (MHz)
T-7	7.00	45	657.25
T-8	13.00	46	663.25
T-9	19.00	47	669.25
T-10	25.00	48	675.25
T-11	31.00	49	681.25
T-12	37.00	50	687.25
T-13	43.00	51	693.25
14	471.25	52	699.25
15	477.25	53	705.25
16	483.25	54	711.25
17	489.25	55	717.25
18	495.25	56	723.25
19	501.25	57	729.25
20	507.25	58	735.25
21	513.25	59	741.25
22	519.25	60	747.25
23	525.25	61	753.25
24	531.25	62	759.25
25	537.25	63	765.25
26	543.25	64	771.25
27	549.25	65	777.25
28	555.25	66	783.25
29	561.25	67	789.25
30	567.25	68	795.25
31	573.25	69	801.25
32	579.25	70	807.25
33	585.25	71	813.25
34	591.25	72	819.25
35	597.25	73	825.25
36	603.25	74	831.25
37	609.25	75	837.25
38	615.25	76	843.25
39	621.25	77	849.25
40	627.25	78	855.25
41	633.25	79	861.25
42	639.25	80	867.25
43	645.25	81	873.25
44	651.25	82	879.25
		83	885.25

NOTE: Audio carrier frequency is 4.5 MHz above video carrier frequency for both standard (STD) and harmonically related carrier (HRC) channels.

NOTES

MANUAL CHANGES

MANUAL CHANGES

-21.5

dBmV/VOLTAGE/POWER CONVERSION

dBmV	VOLTAGE	POWER	dBmV	VOLTAGE	POWER
+60	1000 mVRMS	13.3 mW	+9	2.82 mVRMS	106 nW
+59	891 ↓	10.6 ↓	+8	2.51 ↓	84.1 ↓
+58	794	8.41	+7	2.24	66.8
+57	708	6.68	+6	2.00	53.1
+56	631	5.31	+5	1.78	42.2
+55	562	4.22	+4	1.59	33.5
+54	501	3.35	+3	1.41	26.6
+53	447	2.66	+2	1.26	21.1
+52	398	2.11	+1	1.12	16.8
+51	355	1.68	0	1.00	13.3
+50	316	1.33	-1	891 μVRMS	10.6
+49	282	1.06 μW	-2	794 ↓	8.41
+48	251	841 ↓	-3	708	6.68
+47	224	668	-4	631	5.31
+46	200	531	-5	562	4.22
+45	178	422	-6	501	3.35
+44	159	335	-7	447	2.66
+43	141	266	-8	398	2.11
+42	126	211	-9	355	1.68
+41	112	168	-10	316	1.33
+40	100	133	-11	282	1.06
+39	89.1	106	-12	251	841 pW
+38	79.4	84.1	-13	224	668 ↓
+37	70.8	66.8	-14	200	531
+36	63.1	53.1	-15	178	422
+35	56.2	42.2	-16	159	335
+34	50.1	33.5	-17	141	266
+33	44.7	26.6	-18	126	211
+32	39.8	21.1	-19	112	168
+31	35.5	16.8	-20	100	133
+30	31.6	13.3	-21	89.1	106
+29	28.2	10.6	-22	79.4	84.1
+28	25.1	8.41	-23	70.8	66.8
+27	22.4	6.68	-24	63.1	53.1
+26	20.0	5.31	-25	56.2	42.2
+25	17.8	4.22	-26	50.1	33.5
+24	15.9	3.35	-27	44.7	26.6
+23	14.1	2.66	-28	39.8	21.1
+22	12.6	2.11	-29	35.5	16.8
+21	11.2	1.68	-30	31.6	13.3
+20	10.0	1.33	-31	28.2	10.6
+19	8.91	1.06	-32	25.1	8.41
+18	7.98	841 nW	-33	22.4	6.68
+17	7.08	668 ↓	-34	20.0	5.31
+16	6.31	531	-35	17.8	4.22
+15	5.62	422	-36	15.9	3.35
+14	5.01	335	-37	14.1	2.66
+13	4.47	266	-38	12.6	2.11
+12	3.98	211	-39	11.2	1.68
+11	3.55	168	-40	10.0	1.33
+10	3.16	133			